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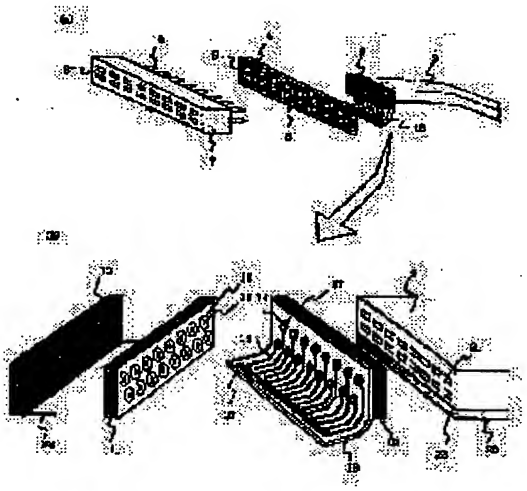
(54) OPTICAL WIRING DEVICE, ITS DRIVING METHOD AND ELECTRONIC APPARATUS USING THE DEVICE

(57)Abstract:
PROBLEM TO BE SOLVED: To provide an optical connector device which includes a connector and waveguide for optical interconnection containing an optical element, may be reduced in cost and facilitates handling.
SOLUTION: This device has an electrical conector part 7 which is attachable and detachable to and from outside, a light transmission means 3 which is capable of transmitting a light signal and an optical element 11 for photoelectric conversion. The optical element 11 consists of and is integrated with at least either of light emitting elements which are connected by the conductive parts 9 of the electrical conector part 7 and are modulated by electric signals and light receiving elements which convert the light signals transmitted by the light transmission means 3 into the electric signals for connection to the conductive parts 9 of the electrical conector part 7. The optical element 11 is so aligned and fixed to be optically coupled to the light transmission means 3.



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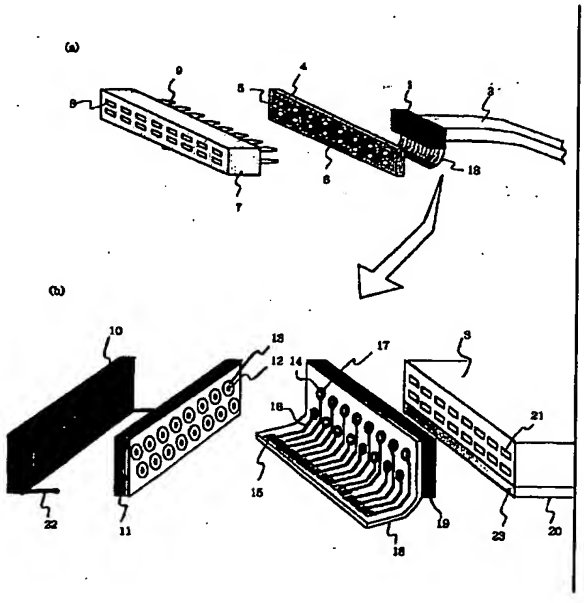
(54)【発明の名称】　光配線装置、その駆動方法およびそれを用いた電子機器

(57)【要約】
【課題】光素子を内蔵した光インターコネクション用のコネクタや導波路を含めた低コスト化可能で取り扱いの容易な光接続装置である。
【解決手段】光接続装置は、外部との間で脱着可能な電気コネクタ部７と、光信号を伝送可能な光伝送手段３と、光電変換するための光素子１１を備える。光素子１１は、電気コネクタ部７の導電部９で接続された電気信号により変調される発光素子及び光伝送手段３で伝送された光信号を電気コネクタ部７の導電部９に接続するための電気信号に変換する受光素子の少なくとも一方から成って集積化されている。光伝送手段３と光結合するように光素子１１はアライメントされて固定されている。



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【特許請求の範囲】

【請求項１】電子機器間、電子機器内における信号接続のための配線ケーブルであって、外部との間で脱着可能な電気コネクタ部と、光信号を伝送可能な光伝送手段と、光電変換するための光素子を備え、該光素子は、該脱着可能な電気コネクタ部の導電部で接続された電気信号により変調される発光素子と、該光伝送手段で伝送された光信号を該電気コネクタ部の導電部に接続するための電気信号に変換する受光素子の少なくとも一方から成って集積化され、該光伝送手段と光結合するように該光素子はアライメントされて固定されていることを特徴とする光配線装置。

【請求項２】光素子は面入出射型の面型半導体光素子であり、該光素子は光伝送手段の光入出射端に面同士を当接させて面実装されていることを特徴とする請求項１記載の光配線装置。

【請求項３】光素子のうち発光素子は面発光レーザであることを特徴とする請求項２記載の光配線装置。

【請求項４】光素子のうち受光素子はｐｉｎ型ホトダイオード或はＭＳＭ型素子であることを特徴とする請求項２記載の光配線装置。

【請求項５】光素子は、アレイ状に並べられて、各素子の独立電極がフリップチップ実装で配線基板に貼り付けられ、前記電気コネクタ部に設けられた構造体に固定されて電気コネクタ部の各導電部から独立に配線されていることを特徴とする請求項１乃至４の何れかに記載の光配線装置。

【請求項６】光素子は、光取り出し用の窓が前記配線基板または構造体に設けられて前記光伝送手段に光結合出来るように面実装で接着されていることを特徴とする請求項５記載の光配線装置。

【請求項７】光素子と電気コネクタ部の各導電部との電気接続に用いる配線基板は自由に曲げることが出来るフレキシブル配線基板であることを特徴とする請求項５または６記載の光配線装置。

【請求項８】光素子を駆動するための電子回路素子が前記電気コネクタ部に同時に集積化されていることを特徴とする請求項１乃至７の何れかに記載の光配線装置。

【請求項９】電子回路素子にはパラレルーシリアル変換機能を含むことを特徴とする請求項８記載の光配線装置。

【請求項１０】同一Ｓｉ基板上に集積化されたＩＣと電気的接触が得られる様に前記光素子のベアチップを直接フリップチップ実装で該Ｓｉ基板上にハイブリッド化した電子回路素子が設けられていることを特徴とする請求項１乃至９の何れかに記載の光配線装置。

【請求項１１】面発光レーザである光素子は、前記構造体或は光伝送手段と配線基板との間にサンドイッチされる形で実装されており、多層膜反射ミラーと活性層を含む共振器層のみ残して半導体基板が除去されて構成されていることを特徴とする請求項５乃至１０の何れかに記載の光配線装置。

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【請求項１２】光伝送手段は、光導波路をホトリソグラフィとエッチングを用いて作製してアレイ状にコアが並べられたシート状のものであり、該光導波路端面にアレイ状の前記光素子が垂直入出射で光結合されて固定されていることを特徴とする請求項１乃至１１の何れかに記載の光配線装置。

【請求項１３】光伝送手段は、光ファイバをアレイ状に並べたものであり、該光ファイバ端面にアレイ状の前記光素子が垂直入出射で光結合されて固定されていることを特徴とする請求項１乃至１１の何れかに記載の光配線装置。

【請求項１４】前記光伝送手段は金属薄膜と接着して成り、該金属薄膜で配線を形成することで光伝送すると共に電気接続も同時に行なうことを特徴とする請求項１２または１３記載の光配線装置。

【請求項１５】脱着可能な電気コネクタ部は、電子機器内に実装したレセプタクルにおいて電気的接続を行なうことを特徴とする請求項１乃至１４の何れかに記載の光配線装置。

【請求項１６】脱着可能な電気コネクタ部は、電子機器内のプリント基板上にハンダ付けすることで電気的接続を行なうことを特徴とする請求項１乃至１４の何れかに記載の光配線装置。

【請求項１７】光素子に面発光レーザを含む請求項１乃至１６の何れかに記載の光配線装置の駆動方法において、面発光レーザの駆動は、前記電気コネクタの導電部と接続された電子機器側の出力段のＣＭＯＳバッファのオン・オフで直接行ない、レーザの駆動電流の調整は直列に挿入した抵抗で行なうことを特徴とする光配線装置の駆動方法。

【請求項１８】大規模中央演算装置（ＭＰＵ）、ランダムアクセスメモリなどの電気集積素子を搭載したプリント基板ボードと他のマルチチップモジュールや記憶装置などの装置を請求項１乃至１６の何れかに記載の光配線装置を用いて接続して構成したことを特徴とする電子機器。

【請求項１９】コンピュータシステムにおいて、ＣＰＵなどを搭載する本体と各種Ｉ／Ｏポートを備えるディスプレイとの間の接続およびローカルエリアネットワークとの接続を請求項１乃至１６の何れかに記載の光配線装置を用いて構成したことを特徴とする電子機器。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、電子機器同志あるいは電子機器内のボード間や、各装置間を光接続するための光配線装置ないし光コネクタ、光導波路ケーブル、その駆動方法等に関する。

【０００２】

【従来の技術】近年、コンピュータ、情報処理、ディスプレイ、プリンタなどを含めた電子機器の高速化に伴い、電子機器内でのボード間やボードと内蔵装置間、あるいは各電子機器間などにおける接続において、電気配線による信号遅延、発熱、電磁放射ノイズ（ＥＭＩ）の発生などの問題が表面化している。その対策は難しく、近い将来、電気配線での限界が見えてくるのは明らかである。

【０００３】装置間では、ギガビットイーサネット（登録商標）やＩＥＥＥ１３９４による高速伝送をツイストペアケーブル等で実現する方式が開発されてきている。高速伝送を実現する伝送方式としては、振幅の小さい差動信号ＬＶＤＳ（Ｌｏｗ　ＶｏｌｔａｇｅＤｉｆｆｅｒｅｎｔｉａｌ　Ｓｉｇｎａｌｉｎｇ）を用いた方式が一般的になっているが、インタフェースＩＣやケーブルが高価（ツイナックスケーブル）なことから、使用範囲は限られ、１Ｇｂｐｓ程度の伝送レートではインピーダンスマッチングの設計が必要でしかも距離としては１０ｍ程度が限界である。

【０００４】また、装置内のボード間では専用ＩＣの不要なパラレル接続も多く用いられているが、トータルレートとして１Ｇｂｐｓを越えると、ピン数、コネクタ信頼性、スペース、チャネル間の遅延すなわちスキューの問題や、ケーブルのコスト、重量など様々な問題がある。

【０００５】さらに、いずれの場合にも、電気接続ではＥＭＩの対策が問題になっており、高速伝送になれば益々これが表面化してくる。

【０００６】一方、これら電気配線の限界をクリアするために、光接続する方法も開発されてきている。この場合、装置内にＥ（電気）／Ｏ（光）、Ｏ／Ｅ変換部を持ち、光コネクタで光ファイバなどを接続して光結合する方式が一般的である。

【０００７】その例として、図１４に示すように（特開平６－１７４９８１号公報）、配線ボード１０５０に２次元アレイ状のＥ／Ｏ、Ｏ／Ｅ変換部を持つ光アクティブレセプタクル１００１を固定して、ここに光コネクタ１０６０を挿入することで光ファイバ１０６１に対して光結合を行なうものがある。これによりバンドルファイバ１０６３で大容量の光インターコネクションが可能となっている。尚、図１４において、１０２０は駆動電子回路、１０４０は光コネクタ部、１０６６は光結合部、１０６７はガイドピンである。

【０００８】この方式は、電気配線におけるような寄生容量による信号遅延やグランドの不安定性からくる信号劣化、あるいは配線から放射されるＥＭＩの放射などがないため、次世代配線技術として期待されている。しかし、光の結合損失を避けるために光コネクタや光素子の実装には精度が要求されてコストが上昇してしまうという問題があるために、なかなか実用化に至らない。また、大容量伝送のために多チャネル化して光結合部分が多くなると、歩留まりやスペースの問題があり、電気配線の代替とする用途は限られていた。さらに、頻繁に脱着する場合の信頼性や、誰にでも扱えるという容易性に欠けており、一般消費者向け電子機器に組み込むには課題が多くあった。

【０００９】そこで、特開平９－８０３６０号公報に開示されているように、光結合部分はコネクタに内蔵して固定し、電気接続で配線ボードと光配線ケーブルをコネクトする方法も考案されている。これを図１５を元に簡単に説明する。有機導波路に光変調器が集積化された光ＭＣＭ（Ｍｕｌｔｉ－Ｃｈｉｐ－Ｍｏｄｕｌｅ）１１０１と光ファイバ１１００が光結合するように固定されており、光変調器の変調信号は電気コネクタ用のピン１１０２を通して入力するようになっている。従って、従来のソケット１１０３に、ピン１１０２、光ＭＣＭ１１０１、光ファイバ１１００が一体化されたコネクタを差し込めば光接続が出来るようになっている。この方法では、光結合部分が固定式なのでコネクタ部分の精度は要求されないために、低コスト化でき、その脱着は簡単で信頼性が高く、一般消費者が光コネクタを扱えるために汎用化出来るという利点があった。

【００１０】

【発明が解決しようとしている課題】しかし、図１５の方式では、上記で述べたようにコネクタ部が電気接続となっているため、扱いが非常に簡便である反面、光ＭＣＭに光変調器という高機能素子などを複数設置するために、コスト高になることや歩留まりの低下および小型化に限界があることなどが問題になっている。また、１つのレーザダイオードからの光出力を分岐するために、マルチチャネル化した場合に光強度の低下が問題になる。さらに、平面光導波路を用いてモジュールを構成しているために、アレイ化した場合に基本的には１次元となり、バンドル光ファイバあるいはシート状のマルチコア光導波路を用いて光接続する場合の光ケーブルが幅広になり、スペースを占めると共に、曲げなどの扱いに制限が生じる。２次元状のバンドルファイバにするには、図１４の例のように２次元アレイ状にした光デバイスと光ファイバあるいは光導波路を結合するようにすればよいが、このようなＥ／Ｏ、Ｏ／Ｅ変換部を内蔵した小型で実用的な光配線用コネクタは開発されていない。

【００１１】そこで、本発明の目的は、Ｅ／Ｏ及び／またはＯ／Ｅ変換部を内蔵した光インターコネクション用のコネクタや導波路を含めた低コスト化可能で取り扱いの容易な光接続装置、およびその駆動方式等を提供することにある。

【００１２】

【課題を解決するための手段】上記目的を達成する光接続装置は、電子機器間、電子機器内における信号接続のための配線ケーブルであって、外部との間で脱着可能な

電気コネクタ部と、光信号を伝送可能な光伝送手段と、光電変換するための光素子（典型的には、面型半導体光素子）を備え、該光素子は、該脱着可能な電気コネクタ部の導電部で接続された電気信号により変調される発光素子（面発光レーザなど）及び該光伝送手段で伝送された光信号を該電気コネクタ部の導電部に接続するための電気信号に変換する受光素子（ｐｉｎ型ホトダイオード、ＭＳＭ型素子など）の少なくとも一方から成って集積化され、該光伝送手段と光結合するように該光素子はアライメントされて固定されていることを特徴とする。これにより、光ファイバや光導波路を用いて光接続をする場合に、脱着が容易で信頼性が高く、低コストな電気コネクタ部による電気接続を介して行えるようにして、光インターコネクションを簡便に行うことが出来る光配線装置が実現される。この構成では、コネクタ内部に光電変換素子を備えて光伝送手段との光結合を固定することで、脱着部は電気コネクタ部で行ないながら信号伝送は光信号で行なうことができ、コネクタ部分の実装コストの低減、信頼性の向上、取り扱いの容易性などの面で優れた高速伝送および低ＥＭＩ化が可能な光インターコネクションが実現出来る。

【００１３】この基本構成に基づいて、以下の如き好適な形態が可能である。光素子は、アレイ状に並べられて、各素子の独立電極がフリップチップ実装で配線基板に貼り付けられ、前記電気コネクタ部に設けられた構造体に固定されて電気コネクタ部の各導電部から独立に配線されている。これにより、光電変換を行なうための発光素子および受光素子を面型の半導体素子にすれば、面実装で小型、低コストな電気および光実装を実現できる。そして、光伝送手段への光実装を垂直入射で行なうことが出来るためにアライメントが容易であり、電気実装も配線用基板にフリップチップ実装を行なうことで、小型で、ワイヤボンディングを必要としないために低コスト化が可能となる。この場合、光素子は、光取り出し用の窓が前記配線基板または構造体に設けられて前記光伝送手段に光結合出来るように面実装で接着され得る。

【００１４】光素子と電気コネクタ部の各導電部との電気接続に用いる配線基板は自由に曲げることが出来るフレキシブル配線基板であり得る。これにより、上記の電気実装において、簡便な実装方法を提供できる。曲げたりすることが簡単なＴＡＢテープなどのフレキシブル基板を用いることで、３次元的に配線が可能であり、実装の自由度が広がる。

【００１５】光素子を駆動するための電子回路素子が前記電気コネクタ部に同時に集積化され得る。これにより、小型で信頼性の高い光電変換機能を持つ集積光電子素子を提供して、上記の光配線装置の低コスト化を図れる。こうして電気コネクタ部内の光電変換部に、発光素子や受光素子を駆動したり、信号のパラレルーシリアル変換を行なうＩＣを集積化させることで、電子機器内の

プリント基板ボードの省スペース化につながる。この場合、電子回路素子にはパラレルーシリアル変換機能を含ませ得る。

【００１６】同一Ｓｉ基板上に集積化されたＩＣと電気的接触が得られる様に前記光素子のベアチップを直接フリップチップ実装で該Ｓｉ基板上に上にハイブリッド化した電子回路素子が設けられ得る。上記駆動ＩＣを構成したＳｉ基板に、直接、発光素子および受光素子のベアチップをフリップチップ実装することで、コネクタの小型化が図れる。

【００１７】面発光レーザである光素子は、前記構造体或は光伝送手段と配線基板との間にサンドイッチされる形で実装されており、多層膜反射ミラーと活性層を含む共振器層のみ残して半導体基板が除去されて構成され得る。これにより、低消費電力駆動およびアレイ化が容易な面発光レーザを発光素子として用い、該面発光レーザを形成した化合物半導体基板を除去して、より小型で、環境安全性の高く高速駆動が可能な光電子集積素子を搭載した光配線装置を提供できる。この構成では、フリップチップ実装等で配線基板または固定するための構造体、ＩＣ基板などに面発光レーザを接着した後に、面発光レーザを構成したＧａＡｓ、ＩｎＰなどの化合物半導体基板を除去して、現れた表面にも再び加工と接着を行い、レーザの機能層を他の物質で挟むような構成にすることで、より小型で、環境安全性の高い光電子集積素子となる。

【００１８】光伝送手段は、光導波路をホトリソグラフィとエッチングを用いて作製してアレイ状にコアが並べられたシート状のものであり、該光導波路端面にアレイ状の前記光素子が垂直入出射で光結合されて固定され得る。これにより、上記光配線装置において、空間多重光伝送を行って伝送容量を上げるための光伝送手段を提供できる。こうして、小型で低コストで大容量の光配線が可能となる。

【００１９】また、光伝送手段は、光ファイバをアレイ状に並べたものであり、該光ファイバ端面にアレイ状の前記光素子が垂直入出射で光結合されて固定され得る。これによっても、上記光配線装置において、空間多重光伝送を行って伝送容量を上げるための光伝送手段を提供できる。光伝送手段として光ファイバをアレイ状にバンドルしたものを用いることでも、小型で低コストで大容量の光配線が可能となる。

【００２０】前記光伝送手段は金属薄膜と接着して成り、該金属薄膜で配線を形成することで光伝送すると共に電気接続も同時に行ない得る。これにより、電気的接続も同時に行うことが出来る伝送手段を提供できる。光伝送手段に金属薄膜による電気配線パターンも接着しておくことで、低周波の信号や電源、グランドの接続などに用いる電気接続も同時に行なうことが出来る。

【００２１】脱着可能な電気コネクタ部は、電子機器内

に実装したレセプタクルにおいて電気的接続を行なう。これにより、電子機器内の配線ボードから上記光配線装置を用いて光インターコネクションを行うための接続方法を提供できる。この接続方法では、簡単に何度も脱着することができ、また信頼性が高く低コストである。

【００２２】脱着可能な電気コネクタ部は、電子機器内のプリント基板上にハンダ付けすることで電気的接続を行なう。これによっても、電子機器内の配線ボードから上記光配線装置を用いて光インターコネクションを行うための接続方法を提供できる。ここでは、電気コネクタの接続を電子機器内のプリント基板上に直接ハンダ付けで行なうことで、プリント基板上の省スペース化につながる。

【００２３】上記目的を達成する光素子に面発光レーザを含む上記の光配線装置の駆動方法は、面発光レーザの駆動を、前記電気コネクタの導電部と接続された電子機器側の出力段のＣＭＯＳバッファのオン・オフで直接行ない、レーザの駆動電流の調整を直列に挿入した抵抗で行なうことを特徴とする。これにより、上記面発光レーザのオン・オフ駆動をＬＳＩなどの出力段のトランジスタで行なって、特別な回路上の変更がなく、低コスト、低消費電力の光配線装置の駆動方法を提供できる。ここでは、上記面発光レーザのオン・オフ駆動をＬＳＩなどの出力段のトランジスタでスイッチングすることで行い、電源電圧に抵抗と面発光レーザが直列に接続されて、その抵抗値で面発光レーザの電流量を決定するので、特別な回路上の変更がなく、低コスト、低消費電力の光配線装置の駆動方法となる。

【００２４】上記目的を達成する電子機器は、大規模中央演算装置（ＭＰＵ）、ランダムアクセスメモリなどの電気集積素子を搭載したプリント基板ボードと他のマルチチップモジュールや記憶装置などの装置を上記の光配線装置を用いて接続して構成したことを特徴とする。これにより、電子機器内で上記光配線装置を用いることで低コストで高速信号処理が可能で、低放射ノイズである装置を提供できる。電子機器内のボードや内蔵装置間の接続を上記光配線装置で行なうことにより、高速信号処理が可能で、ケーブルの省スペース化、低ＥＭＩ化ができ、高周波マッチングの設計の手間が省けるなどの利点がある。

【００２５】上記目的を達成する電子機器は、コンピュータシステムにおいて、ＣＰＵなどを搭載する本体と各種Ｉ／Ｏポートを備えるディスプレイとの間の接続および／またはローカルエリアネットワークとの接続を上記の光配線装置を用いて構成したことを特徴とする。これにより、電子機器同士を上記光配線装置を用いて接続することで低コストで大容量信号伝送を行なうことが出来る装置やネットワークを提供できる。コンピュータ本体とディスプレイ、あるいはＬＡＮ（ローカルエリアネットワーク）との接続において上記光配線装置を用いることで、ケーブルの省スペース化、低ＥＭＩ化ができ、高周波マッチングの設計の手間が省けるなどの利点がある。

【００２６】

【発明の実施の形態】以下に、本発明の具体的な実施の形態を図を参照しつつ説明する。

【００２７】［第１実施例］本発明では、コネクタ部分は従来の電気コネクタを用いて脱着を行い、プラグ側にＯ／Ｅ及び／またはＥ／Ｏの変換機能を集積化して、光素子と光導波路との結合は接着で固定してあり、光コネクタを必要としないことを特徴としている。これにより、脱着が容易で信頼性が高く、光実装部品を大幅に削減して低コストな光接続用コネクタを提供出来る。

【００２８】図１は本発明の第１実施例のコネクタ部分の構成を説明する図である。図１（ａ）において、７は電気接続用のコネクタ部であってメス結合部８および後段のワイヤとの電気接続用のピン９から構成されている。電気接続用コネクタ部７は、従来から用いられている樹脂製のものでよく、この図では２×８の１６個のピン９があるが、ピン数は任意のものでよく、また結合部８はオス型でも勿論よい。

【００２９】このコネクタ部７の後段には、配線パターン（不図示であるが、これは各穴５と電極パッド９を電気的に結合する）と電極パッド６を形成したプレート４がある。プレート４は、上記コネクタ部７のピン９が穴５に差し込まれると共にハンダ付けされることにより、コネクタ部７に固定してある。このプレート４も電気のプリント基板に通常用いられている樹脂などでよい。また、必要であれば、このプレート４上に後述の光素子の駆動用の電子回路を構成しておいてもよい。

【００３０】さらに、その後段には、光素子とマルチコア光導波路３が一体化されたＥ／Ｏ、Ｏ／Ｅ変換部１が接着されている。光素子との電気配線は、電気配線パターンが形成されたフレキシブル基板（ＴＡＢテープなど）１８によって、電極パッド６と接続することにより行う。全てを組み立てた後に、全体をカバーで覆うか、モールド樹脂で固めてハンドリングをしやすいようにする（不図示）。

【００３１】Ｅ／Ｏ、Ｏ／Ｅ変換部１の構成の例を図１（ｂ）に示す。Ｅ／Ｏ変換部の場合には、面発光レーザ１１が２つのプレート１０、１９にサンドイッチされる形で実装されており、ＴＡＢテープ１８により各素子に独立配線が出来るようになっている。すなわち、面発光レーザ１１の発光部１２の周りに設けられたリング電極１３とＴＡＢテープ１８の電極１７がアライメントされて、リング電極１３と電極１７の両者が実装接合面の間に完全に隠れた状態で実装するフリップチップ実装されており、各発光部１２に対応する部分には光透過用の窓１４が設けられている。面発光レーザ１１の共通電極は、プレート１０側に設けられていてもよいし、ＴＡＢ

テープ１８側に出されていてもよい（これについては後述する）。各電極１７は配線１６を介して電極パッド１５に接続され、この電極パッド１５はプレート４に形成された電極パッド６に接続されている。

【００３２】マルチコア光導波路３とは光結合するようにアライメントしてプレート１９と接着剤で固定されている。面発光レーザ１１は出射角が１０°以下と小さいので、たとえばコア２１のサイズが１００μｍ角程度の場合には、プレート１９の厚さが１００μｍ程度であっても光の損失が小さくまた光実装の許容誤差も数１０μｍ程度なので、ガイドピン２２をプレート１０に形成しておいて、マルチコア光導波路３に設けた穴２３に差し込む程度のパッシブアライメントで対応出来る。光導波路３としてコア径５０μｍのバンドル光ファイバを用いる場合には、窓部１４にレンズを嵌め込むことで結合効率を上げてもよい。

【００３３】また、プレート１０、１９およびＴＡＢテープ１８の素材は、光素子１１の熱放散のために熱伝導性が高いものが望ましく、プレート１０、１９には金属かＡｌ$_2$Ｏ$_3$またはＡｌＮセラミック薄膜を用い、ＴＡＢテープ１８にはＡｌ$_2$Ｏ$_3$粉末入りのポリイミドフィルムなどを用いる。さらに、光素子１１からの放熱性を上げるために、プレート１０をプレート４に接着する接着面に金属膜および放熱フィン（不図示）を付けてもよい。

【００３４】ここでは、Ｅ／Ｏ変換素子を例にとって説明したが、Ｏ／Ｅ変換素子の場合は、面型受光素子としてｐｉｎ型ホトダイオードやＭＳＭ（ｍｅｔａｌ－ｓｅｍｉｃｏｎｄｕｃｔｏｒ－ｍｅｔａｌ）型素子などを用い、面発光レーザの場合と同様に実装を行なう。ｐｉｎ型ホトダイオードの電極は上記電極の構造とほぼ同じであり、ＭＳＭ型素子の電極は櫛型電極が同一面に出ている。

【００３５】なお、以上述べてきたコネクタでは一方向の接続、すなわち光ケーブル３の片端がＥ／Ｏ変換部、もう一方の端がＯ／Ｅ変換部となっている場合を想定しているが、両方のコネクタ内にＥ／Ｏ、Ｏ／Ｅの両方を備えて双方向の接続が可能な様にしても勿論よい。その場合は、図２のように光素子を面発光レーザ１１と面型受光素子２４（受光部２５と電極２６を持つ）に分けて、同一プレート１９上にフリップチップ実装するようにすればよい。この図では、その他の構成はすでに述べたものと同様である。面発光レーザと面型受光素子を同一基板上に作製して、一体型の素子を図１のように実装しても勿論よい。また、コネクタの差込方向と光ケーブル３の方向が同じケーブルについて示したが、図３のようにＥ／Ｏ、Ｏ／Ｅ変換部の接着方向を変えればＬ型コネクタにすることが簡単に出来る。

【００３６】次に、光配線用のマルチコア光導波路３について説明する。導波路の材料としては、フッ素化ＰＭＭＡやエポキシ樹脂、ポリイミドなどの樹脂で形成するのが簡便でよい。その作製方法を図４を元に簡単に説明する。

【００３７】先ず、図４（ａ）に示す様に、Ｓｉ基板４１上に、クラッドとなる樹脂４２をスピナーなどで塗布後に硬化させ、さらにコアとなる屈折率の若干高い層４３を同様に形成した後に、ホトリソグラフィーにより導波路形状にパターニングしたレジスト４４を形成ずる。

【００３８】次に、図４（ｂ）に示す様に、酸素プラズマを用いた反応性イオンエッチング（ＲＩＥ）によって導波路パターンを形成した後、レジスト４４を除去する。更に、図４（ｃ）に示す様に、クラッドとなる樹脂４２を埋め込むように形成し、エッチバックにより表面を平坦化する。

【００３９】図４（ｄ）に示す様に、さらに同様に光導波路形状にコア層４３を形成する。このとき、上下の導波路４３の位置は、マスクの合わせマークにより精度良く合わせることが出来る。そして、図４（ｅ）に示す様に、同様にクラッドとなる樹脂４２を埋め込むように形成して平坦化する。

【００４０】最後に、図４（ｆ）に示す様に、最終クラッド層４２上に金属厚膜２０を形成して、Ｓｉ基板４１を機械研磨およびＫＯＨなどのウエットエッチングにより除去すれば、図１の符号３で示すようなフレキシブルなマルチコア光導波路が作製出来る。

【００４１】このとき、コア４３の断面は１００μｍ×８０μｍであり、上下とも２５０μｍピッチで並んでおり、最後の支持基板となる金属層２０は銅で厚さ１００μｍとした。この金属層２０はメッキで形成してもよいし、銅薄膜を接着する方法でもよく、材料もこれに限ったものではない。このように金属層２０を形成しておけば、光導波路３の支持の機能だけでなく、光素子の放熱の機能を持たすことも出来る。また、装置内で用いる場合にはボード間の電気的共通ラインを接続することに用いたり、金属層２７を図５のように配線パターンとして形成すれば電気的接続も同時に行なうことも出来る。これは、比較的遅い信号やアナログ信号の接続や給電ラインなどとして利用することが出来る。この場合、コネクタ部７のピン９の数を増やして、その一部にこの電気配線と接続するような配線を設けることになる。

【００４２】一方、導波路の材料としては他にも色々あり、低損失材料としてシリカガラスを用いたものでもよい。この場合、Ｐをドープしたシリカガラス（ＰＳＧ）を用いると、加熱することでマストランスポートが起きて表面平坦化出来るので、多層光配線層として作製しやすい。このとき、コア層２１としてＧｅをさらにドープしたＧＰＳＧで屈折率制御を行なえば光導波路を構成出来る。

【００４３】次に、Ｅ／Ｏ変換に用いる面発光レーザについて説明する。通常、面発光レーザは、ｎ基板上に、

活性層を含む共振器をＤＢＲ（Ｄｉｓｔｒｉｂｕｔｅｄ Ｂｒａｇｇ Ｒｅｆｌｅｃｔｏｒ）ミラーでサンドイッチした構造をエピタキシャル成長し、発光部だけに電流が流せるような狭窄構造を形成したもので、簡単に図１（ｂ）の符号１１のように２次元アレイ化出来る。ここでは、ＧａＡｓ基板上にＡｌＡｓ／ＡｌＧａＡｓ多層膜エピミラーを成長し、ＧａＡｓ／ＡｌＧａＡｓの多重量子井戸活性層を持つ８３０ｎｍ帯の面発光レーザを使用した。この場合、共通電極はカソードになり、独立駆動するための電極１３はアノードになっている。

【００４４】この面発光レーザを駆動するためのＥ／Ｏ変換部の概念図を図８（ｂ）に示す。コネクタ部７のピン９に繋がるＬＳＩの最終段には電流駆動が出来るようにＣＭＯＳバッファインバータ８１が構成されているが、本発明ではこの最終段の構成を変えることなしに、金属ケーブルで接続する替わりに面発光レーザでＥ／Ｏ変換して光導波路３で接続する。ＣＭＯＳバッファの駆動電流能力は通常１０ｍＡ以下であるが、ここで使用した面発光レーザはしきい値が約１ｍＡ、１００μＷ出力時の動作電流は３ｍＡと非常に低いので、充分駆動することが出来る。面発光レーザ８２に３ｍＡの電流を流すときの動作電圧は約２．５Ｖであるため、３．３Ｖ－ＣＭＯＳの場合には直列抵抗Ｒとして、（３．３－２．５）／３×10^{-3}＝２６７Ωの抵抗Ｒを挿入すればよい。この抵抗は図１におけるプレート４の配線中に挿入（不図示）すればよい。

【００４５】しかし、この系ではカソードコモンで動作させる為にＣＭＯＳのｐチャネルで電流駆動させることになり、そのスイッチング時間が効いてくる為に高速化には限界がある。一方、図８（ａ）のようにアノードコモンタイプにすればｎチャネルＭＯＳで電流駆動するＣＭＯＳを選べるので、更なる高速化が図れるメリットがある。そのため、本発明では、面発光レーザのｎ基板を除去してｎ側を電極分離することでアノードコモン化する技術も開発している。その作製方法を図６に示す。

【００４６】図６は、簡略化のため、２個のみの面発光レーザのアレイの断面を示している。図６（ａ）において、ｎ－ＧａＡｓ基板６０上に、エッチストップ層となるｎ－ＡｌＡｓ層（不図示）、コンタクト層となるｎ－ＧａＡｓ（不図示）を成長してから、ｎ－ＡｌＡｓ／ＡｌＧａＡｓ多層膜ミラー６１、アンドープのＧａＡｓ／ＡｌＧａＡｓ多重量子井戸活性層とＡｌＧａＡｓ層からなる１波長共振器層６２、ｐ－ＡｌＡｓ／ＡｌＧａＡｓ多層膜ミラー６３を有機金属気相成長法などでエピタキシャル成長する。その後、電流狭窄層６６を形成する為にリング状にエッチングを行なって凹部６７を形成してから、ＳｉＮｘなどの絶縁膜６４を発光領域部を除いて成膜して電極６５を形成する。

【００４７】次に、図６（ｂ）において、プレート１０の全面電極（不図示）に、ｐ側の電極６５全体をＡｕＳｎハンダによって接着してから、ＧａＡｓ基板６０を研磨および化学的エッチングにより除去する。このとき、エッチャントはH_2O_2とNH_3の混合液を用いており、ＧａＡｓ基板６０上に成長してあるＡｌＡｓ層でエッチングを止めることが出来る。その後、直ちにＨＣｌによってＡｌＡｓ層を除去してミラー６１最下面に成長しているＧａＡｓ層を露出させる。続いて、図６（ｃ）において、表面に露出しているミラー層６１の素子間部分を硫酸系のエッチャント等でウエットエッチングして分離溝６８を形成し、ｎ側の電極１３を窓部１２を形成しながら成膜する。

【００４８】次に、もう１つのプレート１９に貼り付けられたＴＡＢテープ１８の穴１４の周りの電極１７と面発光レーザの電極１３同志をやはりＡｕＳｎハンダなどで接着する。すると、窓部１４から光を取り出せるアノードコモン型面発光レーザが作製出来る。これをマルチコア光導波路３のコア２１に光結合が行われるようにアライメントしてプレート１９と導波路３の端面を接着すればよい。

【００４９】また、作製方法の若干の違いで、図７のような方法もある。この場合、図１と若干構成が異なって、配線用のＴＡＢテープ１８が光導波路３の反対側のプレート１０から出る構造になっている。図７（ａ）において、図６（ａ）の場合と同様に面発光レーザ構造を作製するが、光をｐミラー層６３側から取り出すために、電極６５には光取り出し用の窓７０を開けておく。また、ｐ側を石英ガラス板６９にエレクトロンワックスなどで貼り付ける。

【００５０】図７（ｂ）において、図６（ｂ）の場合と同様にＧａＡｓ基板６０を除去して電極７１を形成する。このとき、共通電極となるｐ電極６５も同一面から取り出せるように、発光部のない領域にスルーホール電極７４を絶縁層７５と共に設けてパッド７６であるアノード電極をカソード電極と同じ側に作製する。そして、プレート１０にＴＡＢテープ１８を貼り付けてＴＡＢテープ上の電極７２、７３とレーザのカソード電極７１および共通アノード電極７６を夫々接着する。このとき、こちら側から光は取り出さないために電極７１、７２に窓を開ける必要はない。これらの作業をやり易くする為に、ｐ側を上記石英ガラス板６９に貼り付けるのである。

【００５１】図７（ｃ）において、石英ガラス板６９を取り外し、この側の電極６５を、光導波路３のコア２１と光結合するようにアライメントしてから光導波路３の端面に接着する。この例では、レーザ出射部とコア２１が近接しているので光の結合損失が極めて小さくなる。

【００５２】このように、ＧａＡｓ基板６０を除去した構成では、レーザ光を発振させる機能層が薄くなっており、Ｅ／Ｏ変換部が非常にコンパクトになると共に、Ａｓ含有率を大幅に下げられるので環境安全性も高くな

る。また、この機能部が図６の形態では２つの構造体１０、１９に挟まれるので、これら構造体に熱伝導性の高い物質を用いれば、よりレーザ特性を向上出来る。

【００５３】ところで、面型発光素子として発光ダイオードを使用することも出来るが、動作電流は３０ｍＡ程度と１桁大きくなり、消費電力が高くなると共にドライバ部分の工夫が必要になる。また、面型受光素子については詳しく触れなかったが、構成や作製方法は類似しており、ＧａＡｓのｐｉｎ構造をエピタキシャル成長および拡散して作製している。材料はＳｉやＩｎＧａＡｓでもよい。ＭＳＭ型の場合はＧａＡｓ上にＡｌなどで櫛形電極を形成すればよい。受光素子の駆動回路には増幅器および判別回路が必要になるので、このような電子回路は上記に述べたようにコネクタ部７後段の配線を形成したプレート４上などに構成すればよい。

【００５４】また、ここでは８３０ｎｍ帯の例を示したが、他の波長帯、すなわちＩｎＧａＡｓによる０．９８μｍ帯やＩｎＧａＡｓＰによる１．３μｍ帯などでも勿論よい。

【００５５】［第２実施例］第１実施例では主にパラレル配線に用いる場合の光配線用コネクタであったが、ピン数が増えるとコネクタ部の占める面積およびマルチコア光導波路の体積が大きくなってしまう。

【００５６】そこで本実施例では、１部をシリアル化してピン数を減少させると共に光素子の特徴である高速伝送を利用するものである。本実施例では図９（ａ）のようにコネクタピン（オス）９１がベースプレート９０に固定されており、ボードとは、図９（ｂ）のようにボード１００上に実装されたメスコネクタ９８で接続するか、図９（ｃ）のように直接ボード１００にハンダ付け（符号１０３で示す）して接続している。ベースプレート９０の後段には、パラレルーシリアル変換用ＩＣおよびレーザ駆動用ＩＣが集積されたＳｉ－ＩＣのベアチップ９２があり、面型光素子９３（図９（ａ）では透視図になっている）がこのＬＳＩにフリップチップ実装されてスタックされている。さらに、光素子９３とマルチコア９４の光導波路９５とが光結合するようにアライメントされて接着されており、光導波路９５にはカバー兼ハンドリング用となる終端ソケット９６が接着されている。

【００５７】次に、Ｓｉ－ＩＣ９２と光素子９３の構成について説明する。面発光レーザの部分の断面図を示したものが図１０である。符号９２は上記で説明したＳｉ－ＩＣであり、図１０では示していないがベースプレート９０上に実装されてピン９１と電気的に接続されるようになっている。Ｓｉ－ＩＣ９２には光素子９３が実装される領域を設けてあり、ＩＣ９２の電極とは配線１０６介して接続される。この配線１０６と面型光素子９３は図１０のように電極７１、７６がアライメントされてフリップチップ実装されている。

【００５８】図１０に示してある面型光素子９３の断面図は第１実施例で示した図７の面発光レーザと同じである。図１０において、図７の符号と同じものは同一機能部であることを示す。ただし、ＴＡＢテープ１８が不要であること、光導波路９５との接着面に熱伝導性を高めて光素子９３を補強するためのセラミックプレート１０５が備えられていることのみが異なる。ここで、符号９２はＳｉ－ＩＣとしたがシリアルーパラレル変換が不要である場合には単なる配線基板として利用する。また、面発光レーザを例にとって図示したが、面型受光素子も同様に実装され、図９（ａ）に示したような２×２で４本のコア９４を持つ場合には、面発光レーザと面型受光素子を２個ずつとしてもよい。

【００５９】次に、ボード１００への接続方法について図９（ｂ）、（ｃ）をもとに更に詳しく説明する。図９（ｂ）はボード１００にソケット９８を用意する場合であり、板バネ状のスプリング９９とピン９１が接続されるようになっている。ソケット９８からのピン１０１がボード１００にハンダ付け（符号１０２で示す）されている。図９（ｃ）はソケットを省略してボード１００に直接コネクタピン９１をハンダ付け（１０３）する場合である。この場合、ピン９１は表面実装が出来るようにベースプレート９０と平行にピンが出るタイプのフラット型としてもよい。

【００６０】また、図９（ｂ）、（ｃ）の断面図において、９７は、ベースプレート９０、Ｓｉ－ＩＣ９２、光素子９３、光導波路９５をスタックした後に施される補強とカバーを兼ねた部材であり、図９（ａ）では省略している。一方、マルチコア９４の光導波路９５は第１実施例と同様のものでもよいし、コア数が少ない場合には１次元アレイの光導波路としてもよい。もちろん１次元状に光ファイバを並べたアレイファイバでもよい。このように１次元アレイにした場合には、光素子として端面から発光、受光を行なう導波路型デバイスを用いてもよい。

【００６１】以上、第１、第２実施例のような光配線素子を用いて構成した全体イメージの例を図１１に示す。図１１において、３０は光電気混載基板としてのマザーボード、３２は大規模中央演算処理装置（ＭＰＵ）、３１は１次キャシュメモリ、３３はＤＲＡＭが搭載されたＭＣＭモジュールがドーターボードとしてマザーボード３０に装着されているものである。ボード３０、３３内の信号伝送は配線３４で行われるが、高速信号の場合には一部光導波路としてもよい。ボード間のパラレル接続には、本発明による第１実施例の光ー電気変換内蔵コネクタ３５およびマルチコア光導波路３６を用いて接続を行なう。光導波路３６は従来の電気配線に比べて体積が小さく、柔軟性も高いために配線が高密度になったときにも脱着が容易である。また、配線部分での電磁波の干渉がないため、クロストークの問題や装置からの放射ノ

イズが低減されると共に、コネクタ部分３５でのインピーダンスマッチングの必要性がないので設計が容易になる。

【００６２】ハードディスクドライブのような外部記憶装置との信号のやり取りは、本発明による第２実施例のコネクタ３８およびマルチコア導波路３７を用いてシリアル高速転送することがケーブルの低コスト化に繋がってよい。コネクタ部３８には、パラレルーシリアル変換して１０Ｇｂｐｓ程度の転送レートを持つ送受信部を装着している。図１１においては、ボードの主要な部分しか書かれていないが、必要な回路構成にして、本発明による光配線によりボード間接続、装置内の内蔵電子機器間の接続を行なってクロックレートが１ＧＨｚオーバーの次世代コンピュータを構成することが出来る。

【００６３】このときＬＶＤＳ方式を用いることに比べて高速で小型化、低消費電力化が可能で、ＥＭＩ対策が容易な光配線を提供することが出来る。従来の光コネクタを用いた光インターコネクションに対しても、コストケーブルの脱着の信頼性、容易性などの面で有利である。また、コンピュータに限らず、最近の電子機器、例えば携帯電話、デジタルカメラなどではより高速化、小型化が要求されており、同時に低ＥＭＩ化が必須となっている為に、本発明による光配線がこれらの機器には非常に有効になる。

【００６４】［第３実施例］第１、第２の実施例では光導波路として、表面プロセスで作製するマルチコア導波路を用いていたが、装置間の接続のように配線の長さが１ｍ以上になると光ファイバを用いて構成した方がトータルコストの面で有利であり、本実施例ではアレイファイバを用いてコネクタを構成したものである。

【００６５】図１２にその部品構成を説明する斜視図を示す。電気コネクタ部１２０には電気接続用のピン１２１が備えられ、そのピン１２１と接続するようにＳｉ－ＩＣ１２２がフリップチップ実装されている。

【００６６】Ｓｉ－ＩＣ１２２は、第２実施例と同様に、面発光レーザの駆動ＩＣおよび面型受光素子の駆動ＩＣが集積化されたものである。そのＩＣ１２２の一部には、第２実施例と同様に、光素子１２３が実装されるスペースおよび電極パッドがあり、光素子１２３もＩＣ１２２上にフリップチップ実装してスタック化されている。光素子１２３は面発光レーザおよび面型ｐｉｎ－ＰＤから成り、同一基板上に形成されていても、別々に作製して同一Ｓｉ－ＩＣ上にハイブリッド的にフリップチップ実装して一体化したものでもよい。このＳｉ－ＩＣ１２２と光素子１２３とのスタック化は第２実施例と同様に行なえばよい。必ずしも面型素子でなくてもよく、低しきい値の短共振器をもつ端面発光レーザでもよいが、実装は複雑になる。

【００６７】また、光導波路１３０としては２５０μｍピッチで４本のアレイファイバ１２７、１２８を用いた。ファイバとしてはＧＩ（ｇｒａｄｅｄ　ｉｎｄｅｘ）－５０を用いたが、シングルモードファイバやプラスティック光ファイバ（ＰＯＦ）でもよい。特に、ＰＯＦのうちコア１２８が石英でクラッド１２７がプラスティックのＨＰＣＦファイバは、コア１２８が２００μｍφ程度であり、光結合が容易でしかも低損失であるというメリットと低コスト化出来るメリットがある。

【００６８】ファイバのアレイは、Ｖ溝を形成したＳｉ基板１２６に図１２のようにファイバを並べて、上から平坦なＳｉ基板１２５でファイバを押さえて接着剤で固定するだけで簡単に精度よく作製出来る。このアレイファイバ１３０の先端部にはハンドリングを兼ねた補強材１２９を接着して、その端面を研磨する。そして、上記で述べたＩＣ１２２にスタック化された光素子１２３の受・発光部１２４とファイバを光結合が出来るようにアライメントして、補強材１２９の端面を光素子１２３に接着する。コネクタ１２０と補強材１２９の間にはさらに補強を兼ねたカバー部材（不図示）を接着するか、全体をモールド材で固めることで、光電変換機能付きコネクタが完成する。

【００６９】本装置では光ファイバを用いているので伝送距離を１００ｍ以上まで自由に選択出来る。また、光伝送であるために電磁ノイズの混入、放射がなくコネクタ部でのインピーダンスマッチングの必要もない。また、コネクタ部に光結合部がないので信頼性が高く、脱着時の危険性もない。

【００７０】このような光配線は次世代のＩＥＥＥ１３９４による高速な電子機器間の伝送や、コンピュータ間のＧｂｉｔクラスのイーサネットワークなどに利用することが出来る。その例を図１３に示す。

【００７１】図１３では、パンコン本体１３３が液晶ディスプレイ１３４と本発明による光配線１３２で接続されている。液晶ディスプレイ１３４の前面に、キーボード１３７や外部記憶装置１４０を接続出来るポート（ＵＳＢなど）１４１とデジタルビデオ装置１３９を接続するＩＥＥＥ１３９４ポート１４２などが設けられて、ここに配線が接続される。マウス１３８は、赤外線で、やはり液晶ディスプレイ１３４の前面に備えられたセンサ１４３に空間的に接続される。このような構成は次世代用に開発しているパソコンの接続の一例であるが、ユーザーインターフェースを重視するためにディスプレイ前面に接続ポートを設けると、本体１３３とディスプレイ１３４の間には高速伝送が要求される。ここで配線１３２の部分に本発明による電気コネクタ付き光配線を用いれば、低コスト、低ＥＭＩで高速転送が可能な接続を実現出来る。ここでは、コネクタ部に光コネクタを用いていないので、一般消費者が手軽に扱える光配線となる。

【００７２】一方、ハブ１３６との接続やＬＡＮへの接続に関しても、ＧＩＩＩクラスの接続が要求されるようになってくるため、本発明による光配線ケーブル１３５

を用いれば、ケーブルの低コスト化、低重量化、省スペース化を信頼性よく構築できる。以上の実施例では、コネクタ部はすべて電気的な接触を得るためのピンのみを備えるものであったが、一部に光接続を行なうための光コネクタを混在させた光電気混在コネクタであってもよい。

【００７３】

【発明の効果】以上説明した様に、本発明によって、光ファイバや光導波路を用いた光接続をする場合に、脱着が容易で信頼性が高く、低コストな電気コネクタ部による電気接続を介して行える光インターコネクションを実現出来る。また、面実装で小型、低コストな電気および光実装手段を実現出来るので、光インターコネクションを行なうためのコネクタを小型化出来る。

【００７４】また、面発光レーザのオン・オフ駆動をＬＳＩの出力段のトランジスタで行なって、特別なＬＳＩや電気回路上の変更がなく、低コスト、低消費電力の光配線装置の駆動方法も提供出来る。更に、電子機器内で上記光配線装置を用いることで、低コストで、高速信号処理が可能で、低放射ノイズである装置を提供出来る。また、電子機器同士を上記光配線装置を用いて接続することで、低コストで大容量信号伝送を行なうことが出来る装置やネットワークを提供出来る。

【図面の簡単な説明】

【図１】図１は本発明による第１実施例の光配線用コネクタとＥ／Ｏ変換部の構成を説明する分解斜視図である。

【図２】図２はＯ／Ｅ、Ｅ／Ｏ変換部を一体化したコネクタを説明する分解斜視図である。

【図３】図３は本発明によるＬ型のコネクタを説明する分解斜視図である。

【図４】図４は本発明によるアレイ型光導波路シートの作製プロセスを説明する断面図である。

【図５】図５は光配線と電気配線が一体化したシートを説明する斜視図である。

【図６】図６は機能層のみを残した面発光レーザの作製プロセスを説明する断面図である。

【図７】図７は機能層のみを残した別の面発光レーザの作製プロセスを説明する断面図である。

【図８】図８は本発明によるコネクタ部分の発光素子を駆動する方法を説明する図である。

【図９】図９は本発明による第２実施例の光配線用コネクタの構成及び該コネクタとボードとの接続方法を説明する図である。

【図１０】図１０は面発光レーザとＬＳＩを同一基板上に構成した光配線用コネクタの断面図である。

【図１１】図１１は本発明による光接続装置で構成したボード接続の例の斜視図である。

【図１２】図１２は本発明による第３実施例の光配線用コネクタを説明する分解斜視図である。

【図１３】図１３は本発明による光接続装置で構成したコンピュータ機器の例の斜視図である。

【図１４】図１４は光コネクタの従来例の図である。

【図１５】図１５は光配線用コネクタの従来例の図である。

【符号の説明】

１　光電変換部
３、３６、３７、９５　光導波路シート
４　配線用プレート
５　接続用ホール
６、１５、１７、７１、７２、７３、７６、１０６　電極パッド
７、１２０　電気コネクタ
８、１１０３　コネクタの接続用ホール
９　ピン
１０、１９　プレート
１１　発光素子
１２　発光部
１３、２６、６５、７１　電極
１４　光透過窓
１６、３４　電気配線
１８　フレキシブル配線基板
２０　光導波路補強用プレート
２１、９４、１２８　コア
２２　光実装用ガイドピン
２３　光実装用ガイド穴
２４　受光素子
２５　受光部
２７　金属膜配線
３０　電気回路ボード
３１　２次キャッシュ
３２　ＭＰＵ
３３　メモリモジュール
３６、３８　光電変換内蔵コネクタ
４１、６０、６９　基板
４２　クラッド層
４３　コア層
４４　レジスト
４５　金属膜
６１、６３　ＤＢＲミラー
６２　活性層
６４、７５　絶縁膜
６６　発光部
６７　溝部
６８　電極分離溝
７０　窓
７４　スルーホール電極
８１　ＣＭＯＳインバータ
８２　レーザダイード
９０　ベースプレート

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９１、１２１、１１０２　コネクタピン
９２、１２２　電子集積回路
９３、１２３　光素子
９６、９７、１０５、１２９　補強用部材
９８　レセプタクル
９９　電気接触用板ばね
１００　プリント基板
１０１　レセプタクルピン
１０２　ハンダ
１２４　受・発光部
１２５、１２６　ファイバ固定部材
１２７　クラッド
１３０　アレイ光ファイバ
１３２、１３５　光配線装置
１３３　パソコン本体
１３４　ディスプレイ
１３６　ハブ

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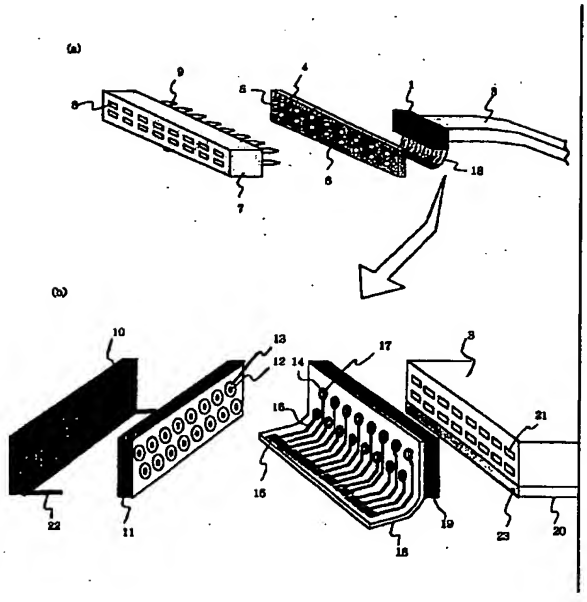
１３７　キーボード
１３８　マウス
１３９　映像機器
１４０　記憶装置
１４１　ＵＳＢポート
１４２　ＩＥＥＥ１３９４ポート
１４３　赤外線受光面
１００１　光レセプタクル
１０２０　駆動電子回路
１０４０　光コネクタ部
１０５０　回路ボード
１０６０　光プラグ
１０６１、１１００　光ファイバ
１０６６　光結合部
１０６７　ガイドピン
１１０１　光電変換集積回路

【図１】



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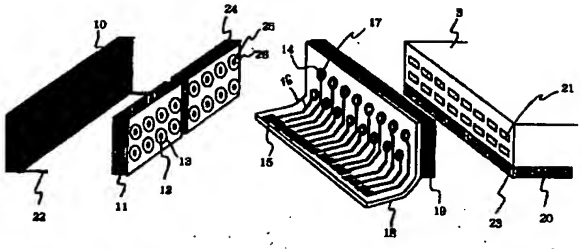
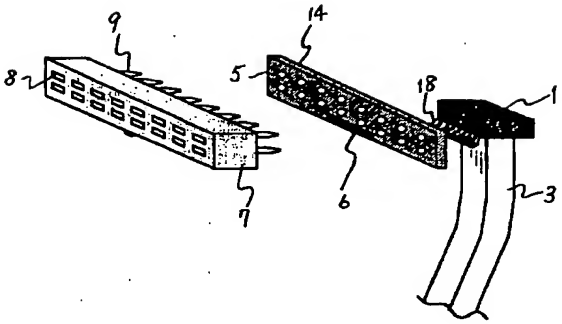


【図３】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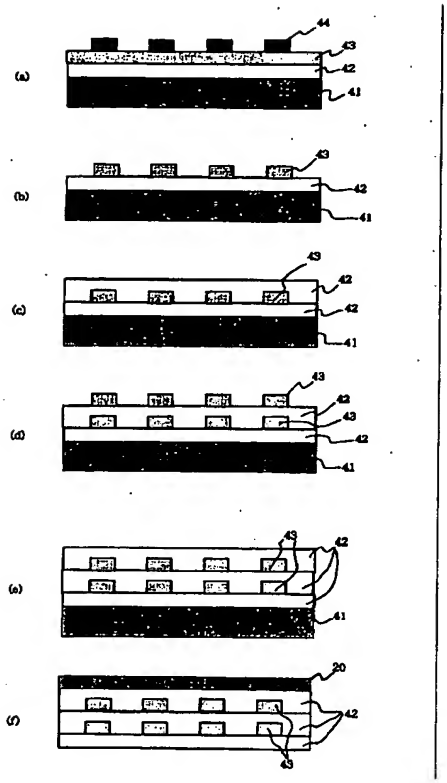
【図４】


(a)
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(b)
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(c)
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(d)
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(e)
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(f)
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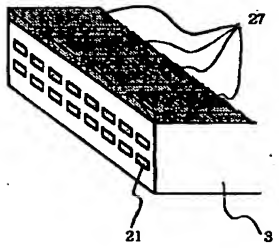
【図５】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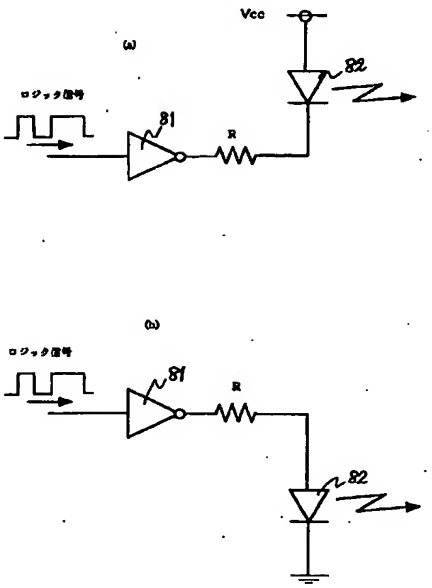
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(b)
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R
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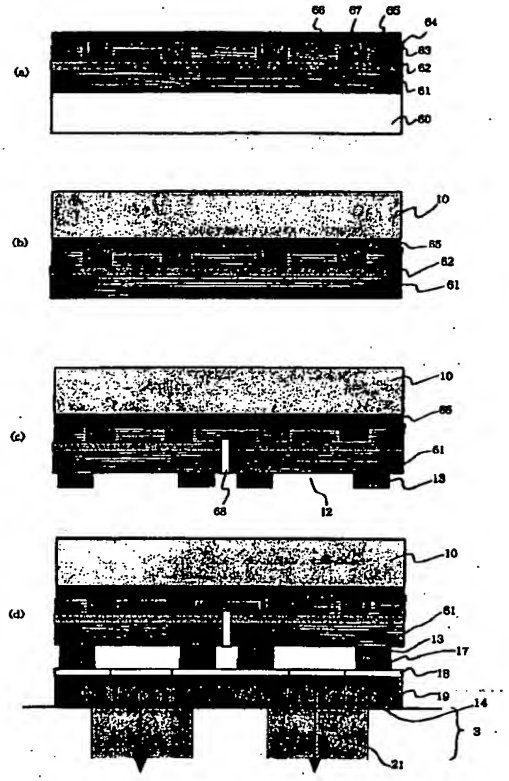
【図６】



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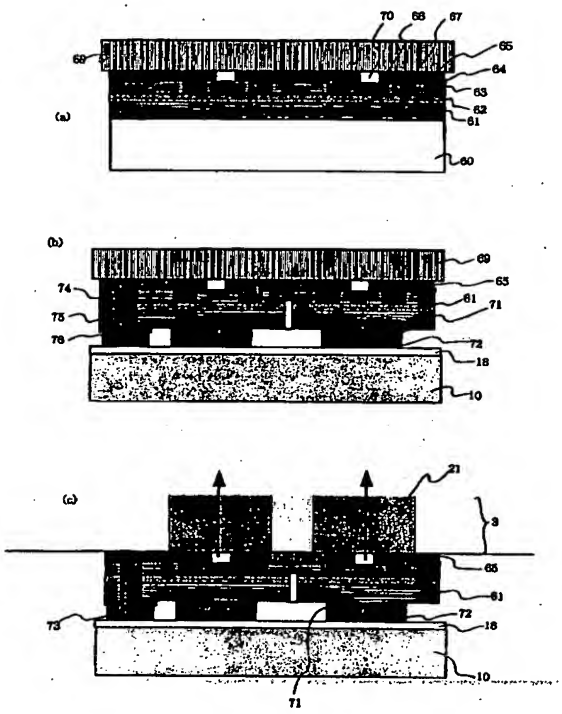

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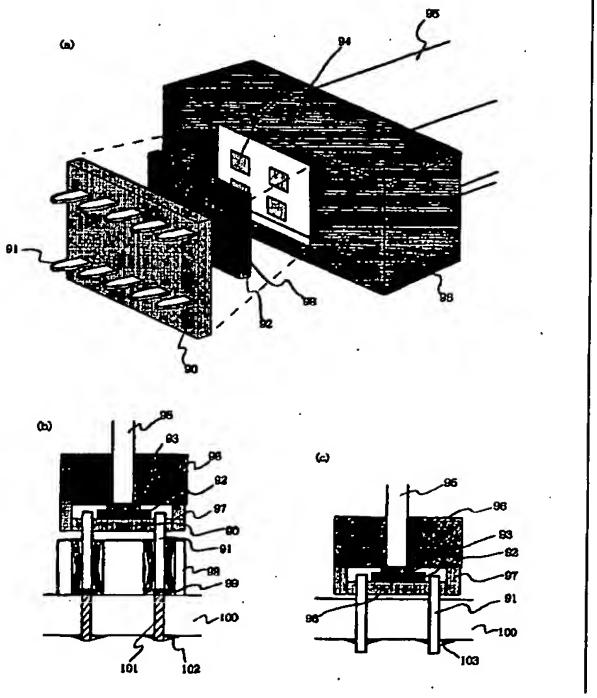

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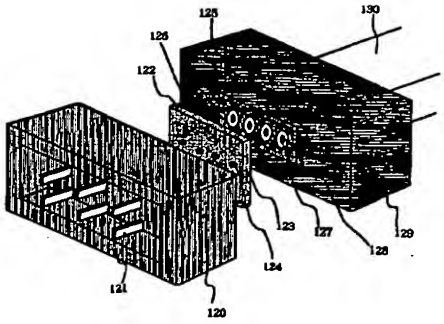

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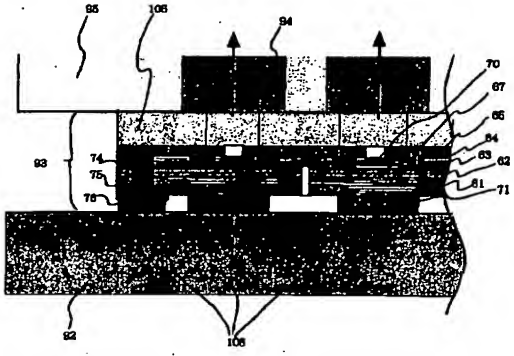
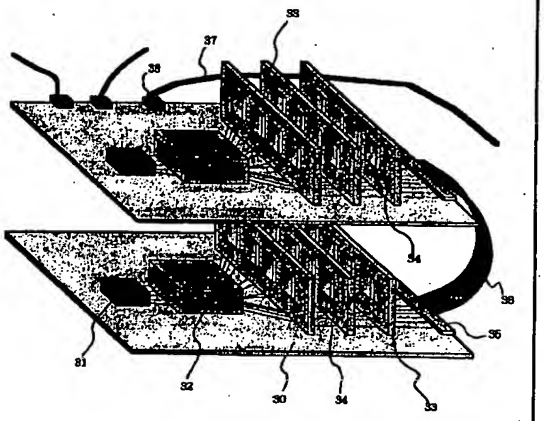
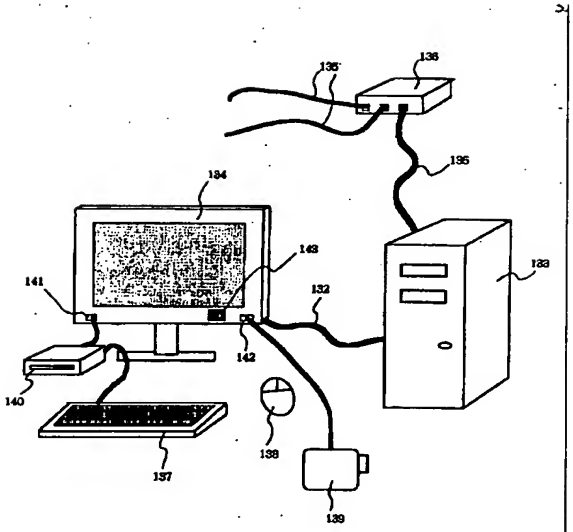


【図１１】



【図１３】



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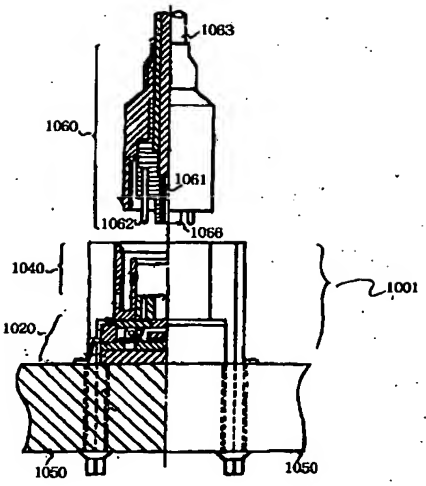

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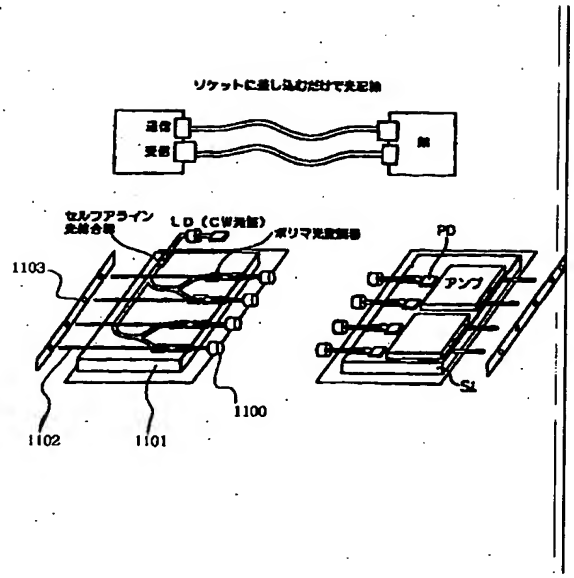

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	5/18	Ｈ０１Ｌ	31/02	Ｃ
Ｈ０４Ｂ	10/14	Ｈ０４Ｂ	9/00	Ｑ
	10/135			
	10/13			
	10/12			

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FA21 FA30
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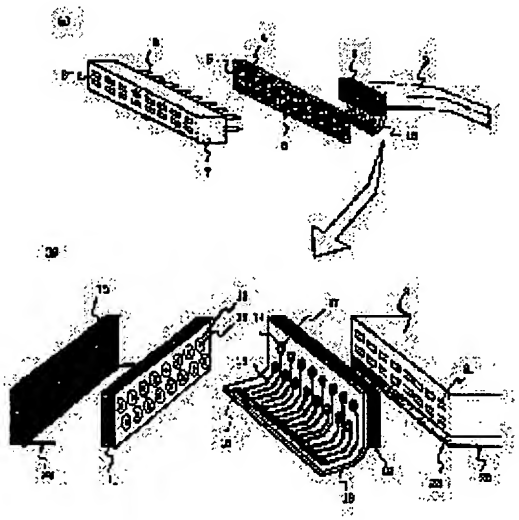
H01R 13/46
H01S 5/022
H01S 5/18
H04B 10/14
H04B 10/135
H04B 10/13
H04B 10/12

(21)Application number : 11-213005
(22)Date of filing : 28.07.1999

(71)Applicant : CANON INC
(72)Inventor : ONOUCHI TOSHIHIKO

(54) OPTICAL WIRING DEVICE, ITS DRIVING METHOD AND ELECTRONIC APPARATUS USING THE DEVICE

(57)Abstract:
PROBLEM TO BE SOLVED: To provide an optical connector device which includes a connector and waveguide for optical interconnection containing an optical element, may be reduced in cost and facilitates handling.
SOLUTION: This device has an electrical conector part 7 which is attachable and detachable to and from outside, a light transmission means 3 which is capable of transmitting a light signal and an optical element 11 for photoelectric conversion. The optical element 11 consists of and is integrated with at least either of light emitting elements which are connected by the conductive parts 9 of the electrical conector part 7 and are modulated by electric signals and light receiving elements which convert the light signals transmitted by the light transmission means 3 into the electric signals for connection to the conductive parts 9 of the electrical conector part 7. The optical element 11 is so aligned and fixed to be optically coupled to the light transmission means 3.



LEGAL STATUS

[Date of request for examination] 15.11.2001
[Date of sending the examiner's decision of rejection]
[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]
[Date of final disposal for application]
[Patent number]

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3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1] It is a distribution cable for the signal connection between electronic equipment and in electronic equipment. The electrical connector section in which desorption is possible between the exteriors, It has a light-corpuscle child for carrying out photo electric translation to an optical-transmission means by which a lightwave signal can be transmitted. this light-corpuscle child The light emitting device modulated by the electrical signal connected by the current carrying part of the electrical connector section in which this desorption is possible, It is optical wiring equipment characterized by carrying out alignment of this light-corpuscle child, and being fixed so that it may consist at least of one side of the photo detector which changes the lightwave signal transmitted with this optical-transmission means into the electrical signal for connecting with the current carrying part of this electrical connector section, it may integrate and optical coupling may be carried out to this optical-transmission means.
[Claim 2] It is optical wiring equipment according to claim 1 which a light-corpuscle child is a field ON outgoing radiation type field type semiconductor light-corpuscle child, and is characterized by for this light-corpuscle child making fields contact the optical ON outgoing radiation edge of an optical-transmission means, and carrying out surface mounting.
[Claim 3] It is optical wiring equipment according to claim 2 characterized by a light emitting device being a surface emission-type laser among light-corpuscle children.
[Claim 4] It is optical wiring equipment according to claim 2 characterized by a photo detector being pin type photo diode or a MSM type element among light-corpuscle children.
[Claim 5] A light-corpuscle child is optical wiring equipment given in the claim 1 or any of 4 they are. [which is characterized by being arranged in the shape of an array, sticking the independent electrode of each element on a wiring substrate by flip chip mounting, being fixed to the structure prepared in the aforementioned electrical connector section, and wiring independently of each current carrying part of the electrical connector section]
[Claim 6] A light-corpuscle child is optical wiring equipment according to claim 5 characterized by having pasted up by surface mounting so that the aperture for optical ejection may be prepared in the aforementioned wiring substrate or the structure and the optical coupling of it can be carried out to the aforementioned optical-transmission means.
[Claim 7] The wiring substrate used for the electrical connection of a light-corpuscle child and each current carrying part of the electrical connector section is optical wiring equipment according to claim 5 or 6 characterized by being the flexible wiring substrate which can be bent freely.
[Claim 8] Optical wiring equipment given in the claim 1 or any of 7 they are. [to which the electronic-circuitry element for driving a light-corpuscle child is characterized by the aforementioned electrical connector section integrating simultaneously]
[Claim 9] Optical wiring equipment according to claim 8 characterized by including a parallel-serial conversion function in an electronic-circuitry element.
[Claim 10] Optical wiring equipment given in the claim 1 or any of 9 they are. [which is characterized by preparing the electronic-circuitry element which hybridized the aforementioned light-corpuscle child's bare chip on this Si substrate by direct flip chip mounting so that IC and electric contact which were integrated on same Si substrate might be obtained]
[Claim 11] The light-corpuscle child who is a surface emission-type laser is optical wiring equipment given in the claim 5 or any of 10 they are. [which is characterized by being mounted in the form sandwiched between the aforementioned structure or an optical-transmission means, and a wiring substrate, leaving only a multilayer reflective mirror and the resonator layer containing a barrier layer, and removing and constituting the semiconductor substrate]
[Claim 12] An optical-transmission means is optical wiring equipment given in the claim 1 or any of 11 they are. [which is the things of the shape of a sheet with which the optical waveguide was produced using phot lithography and

etching, and the core was compared in the shape of an array, and is characterized by carrying out optical coupling of the aforementioned array-like light-corpuscle child to this optical-waveguide end face, and fixing him to it by perpendicular close outgoing radiation]

[Claim 13] An optical-transmission means is optical wiring equipment given in the claim 1 or any of 11 they are. [which is characterized by arranging an optical fiber in the shape of an array, carrying out optical coupling of the aforementioned array-like light-corpuscle child to this optical fiber end face, and fixing him to it by perpendicular close outgoing radiation]

[Claim 14] The aforementioned optical-transmission means is optical wiring equipment according to claim 12 or 13 characterized by performing electrical connection simultaneously while carrying out an optical transmission by pasting up with a metal thin film, changing and forming wiring by this metal thin film.

[Claim 15] The electrical connector section in which desorption is possible is optical wiring equipment given in the claim 1 or any of 14 they are. [which is characterized by performing electrical installation in the receptacle mounted in electronic equipment]

[Claim 16] The electrical connector section in which desorption is possible is optical wiring equipment given in the claim 1 or any of 14 they are. [which is characterized by performing electrical installation with soldering on the printed circuit board in electronic equipment]

[Claim 17] It is the drive method of the optical wiring equipment characterized by performing adjustment of a deed and the drive current of laser by the resistance inserted in series directly in the drive method of optical wiring equipment given in the claim 1 or any of 16 they are by turning on and off of the CMOS buffer of the output stage by the side of the electronic equipment by which the drive of a surface emission-type laser was connected with the current carrying part of the aforementioned electrical connector. [which contains a surface emission-type laser in a light-corpuscle child]

[Claim 18] Electronic equipment characterized by connecting and constituting equipments which carried electric accumulation elements, such as a large-scale central arithmetic unit (MPU) and a RAM, such as a printed circuit board board, and other multi chip modules, storage, using optical wiring equipment given in any [a claim 1 or] of 16 they are.

[Claim 19] Electronic equipment characterized by constituting the connection between the main part in which CPU etc. is carried, and a display equipped with various I/O Ports, and connection with a Local Area Network in a computer system using optical wiring equipment given in any [a claim 1 or] of 16 they are.

[Translation done.]

* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] this invention relates to the optical wiring equipment for making optical connection between the boards in an electronic equipment comrade or electronic equipment, and of between each equipment or an optical connecter, an optical-waveguide cable, its drive method, etc.
[0002]
[Description of the Prior Art] In recent years, in the connection between the boards within electronic equipment, between a board and built-in equipment, or in between each electronic equipment etc., problems, such as generating of the signal delay by electric wiring, generation of heat, and an electromagnetic radiation noise (EMI), have surfaced with improvement in the speed of electronic equipment including a computer, information processing, the display, the printer, etc. The cure is difficult and it is clear that the limitation in electric wiring will be in sight in the near future.
[0003] Between equipment, the method which realizes high-speed transmission by Gigabit Ethernet (registered trademark) or IEEE1394 by the twisted-pair cable etc. has been developed. Although the method using the differential signal LVDS with a small amplitude (Low VoltageDifferential Signaling) is general as a transmission system which realizes high-speed transmission, since Interface IC and a cable are expensive (TSUINAKKUSUKEBURU), the use range is restricted, and needs the design of impedance matching at the transmission rate of about 1Gbps, and, moreover, about 10m is a limitation as a distance.
[0004] Moreover, although many unnecessary parallel connection of exclusive use IC is also used between the boards in equipment, when 1Gbps is exceeded as a total rate, there are various problems, such as delay between the number of pins, connector reliability, a space, and a channel, i.e., the problem of a skew, and cost of a cable, a weight.
[0005] Furthermore, if in any case the cure of EMI has been a problem and becomes high-speed transmission by electrical connection, this will surface increasingly.
[0006] On the other hand, in order to clear the limitation of these electric wiring, the method of making optical connection has also been developed. In this case, the method which has E (electrical and electric equipment)/O (light) and an O/E transducer in equipment, and connects and carries out optical coupling of the optical fiber etc. with an optical connecter is common.
[0007] As the example, as shown in drawing 14 (JP,6-174981,A), the optical active receptacle 1001 which has two-dimensional-array-like E/O and an O/E transducer in the wiring board 1050 is fixed, and there are some which perform optical coupling to an optical fiber 1061 by inserting an optical connecter 1060 here. Thereby, an optical interconnection mass with the bundle fiber 1063 is possible. In addition, for 1020, as for the optical connecter section and 1066, in drawing 14 , a drive electronic circuitry and 1040 are [the optical coupling section and 1067] guide pins.
[0008] Since there is no radiation of EMI emitted from signal degradation which comes from the instability [as / in electric wiring] of the signal delay by the parasitic capacitance or a gland, or wiring etc., this method is expected as next-generation wiring technology. However, since there is a problem that precision will be required of mounting of an optical connecter and a light-corpuscle child, and cost will go up in order to avoid joint loss of light, it does not result in utilization easily. Moreover, when it many channelized and the optical coupling portion increased for mass transmission, there is a problem of the yield or a space and the use considered as an alternative of electric wiring was restricted. Furthermore, there were many technical problems in the reliability in the case of carrying out desorption frequently and the ease that it can treat to anyone being missing, and including in the electronic equipment for general consumers.
[0009] Then, an optical coupling portion is built in and fixed to a connector, and the method of connecting an optical distribution cable with a wiring board by electrical connection is also devised as indicated by JP,9-80360,A. Drawing 15 is explained for this briefly [origin]. It is fixed so that the light (Multi-Chip-Module) MCM 1101 and the optical fiber

1100 by which the optical modulator was integrated by the organic waveguide may carry out optical coupling, and the modulating signal of an optical modulator is inputted through the pin 1102 for electrical connectors. Therefore, if the connector by which a pin 1102, light MCM 1101, and the optical fiber 1100 were united with the conventional socket 1103 is inserted, it has come to be able to perform optical connection. By this method, since an optical coupling portion was fixed and the precision for a connector area was not required,-izing could be carried out [low cost], and the desorption had the advantage that it is easy and is reliable, and it could use widely since a general consumer can treat an optical connecter.

[0010]

[Problem(s) to be Solved by the Invention] However, by the method of drawing 15 , since the connector area serves as electrical connection as stated above, while treatment is very simple, in order to install two or more highly efficient elements called an optical modulator in Light MCM, it has been a problem that a limitation is in cost quantity at a fall and miniaturization of a bird clapper and the yield etc. Moreover, in order to branch the optical output from one laser diode, when it multi-channel-izes, the fall of optical intensity becomes a problem. Furthermore, while becoming one dimension fundamentally, and the optical cable in the case of making optical connection using the multi-core optical waveguide of the shape of a bundle optical fiber or a sheet becoming broad and occupying a space when it array-izes since the module is constituted using a flat-surface optical waveguide, a limit arises in the treatment of bending etc. Although what is necessary is just to combine the optical device, optical fiber, or optical waveguide made into the shape of a two dimensional array like the example of drawing 14 in order to make it a two-dimensional-like bundle fiber, the small and practical connector for optical wiring which built in such E/O and the O/E transducer is not developed.

[0011] Then, low-cost[including the connector or waveguide for the optical interconnections which built in E/O and/or the O/E transducer]-izing is possible for the purpose of this invention, and it is to offer an easy optical contact, its drive method, etc. of handling.

[0012]

[Means for Solving the Problem] The optical contact which attains the above-mentioned purpose is a distribution cable for the signal connection between electronic equipment and in electronic equipment. The electrical connector section in which desorption is possible between the exteriors, The light-corpuscle child for carrying out photo electric translation to an optical-transmission means by which a lightwave signal can be transmitted (typically) It has a field type semiconductor light-corpuscle child. this light-corpuscle child the photo detector (pin type photo diode --) which changes the lightwave signal transmitted with the light emitting devices (surface emission-type laser etc.) and this optical-transmission means which are modulated by the electrical signal connected by the current carrying part of the electrical connector section in which this desorption is possible into the electrical signal for connecting with the current carrying part of this electrical connector section It consists at least of one side, such as a MSM type element, and integrates, and this light-corpuscle child is characterized by carrying out alignment and being fixed so that optical coupling may be carried out to this optical-transmission means. Thereby, when making optical connection using an optical fiber or an optical waveguide, desorption is easy, it is reliable and the optical wiring equipment which can perform an optical interconnection simple as can carry out through the electrical connection by the low cost electrical connector section is realized. With this composition, while the desorption section performs an optoelectric transducer in the electrical connector section by fixing optical coupling with an optical-transmission means in preparation for the interior of a connector, a signal transmission can realize the optical interconnection in which the high-speed transmission and the reduction in EMI which could carry out by the lightwave signal and were excellent in fields, such as reduction of the mounting cost for a connector area, improvement in reliability, and the ease of handling, are possible.

[0013] Based on this basic composition, the suitable gestalt like a less or equal is possible. A light-corpuscle child is arranged in in the shape of an array, and the independent electrode of each element is stuck on a wiring substrate by flip chip mounting, it is fixed to the structure prepared in the aforementioned electrical connector section, and he is wired independently of each current carrying part of the electrical connector section. If the light emitting device and photo detector for performing photo electric translation are made into a field type semiconductor device by this, small, the low cost electrical and electric equipment, and optical mounting are realizable by surface mounting. And since optical mounting to an optical-transmission means can be performed by vertical incidence, it is small because alignment is easy and electric mounting also performs flip chip mounting to the substrate for wiring, and since wirebonding is not needed, low-cost-ization is attained. In this case, a light-corpuscle child can paste up by surface mounting so that the aperture for optical ejection may be prepared in the aforementioned wiring substrate or the structure and the optical coupling of it can be carried out to the aforementioned optical-transmission means.

[0014] The wiring substrate used for the electrical connection of a light-corpuscle child and each current carrying part of the electrical connector section may be a flexible wiring substrate which can be bent freely. Thereby, the simple

mounting method can be offered in the above-mentioned electric mounting. By using flexible substrates, such as a TAB tape with it easy [to bend], it can wire in three dimensions and the flexibility of mounting spreads.
[0015] The electronic-circuitry element for driving a light-corpuscle child may be simultaneously integrated by the aforementioned electrical connector section. Thereby, it is small, and an accumulation photoelectron element with reliable photoelectrical converter ability is offered, and low-cost-ization of above optical wiring equipment can be attained. In this way, a light emitting device and a photo detector are driven to the photoelectrical transducer of electrical connector circles, or it leads to ** space-ization of the printed circuit board board in electronic equipment by making IC which performs parallel-serial conversion of a signal integrate. In this case, a parallel-serial conversion function may be included in an electronic-circuitry element.
[0016] The electronic-circuitry element which hybridized the aforementioned light-corpuscle child's bare chip upwards on this Si substrate by direct flip chip mounting so that IC and electric contact which were integrated on same Si substrate might be obtained may be prepared. To Si substrate which constituted the above-mentioned drive IC, the miniaturization of a connector can be attained by carrying out flip chip mounting of the bare chip of a light emitting device and a photo detector directly.
[0017] He is mounted in the form sandwiched between the aforementioned structure or an optical-transmission means, and a wiring substrate, and the light-corpuscle child who is a surface emission-type laser leaves only a multilayer reflective mirror and the resonator layer containing a barrier layer, and a semiconductor substrate is removed and he may be constituted. The compound semiconductor substrate in which a low-power drive and array-ization formed this surface emission-type laser by this, using easy field luminescence laser as a light emitting device is removed, it is more small and the optical wiring equipment which carried the high photoelectron accumulation element of environmental safety which can be driven high-speed can be offered. With this composition, after pasting up a surface emission-type laser on a wiring substrate or the structure for fixing, IC substrate, etc. by flip chip mounting etc., compound semiconductor substrates which constituted the surface emission-type laser, such as GaAs and InP, are removed, and processing and adhesion are again performed also on the front face which appeared, and by making it composition which sandwiches the stratum functionale of laser by other matter, it is more small and becomes the high photoelectron accumulation element of environmental safety.
[0018] An optical-transmission means is the thing of the shape of a sheet with which the optical waveguide was produced using phot lithography and etching, and the core was compared in the shape of an array, and optical coupling of the aforementioned array-like light-corpuscle child is carried out to this optical-waveguide end face by perpendicular close outgoing radiation, and it may be fixed to it. The optical-transmission means for performing a space multiplex optical transmission and raising transmission capacity in the above-mentioned optical wiring equipment, by this, can be offered. In this way, it is small and optical wiring mass by the low cost is attained.
[0019] Moreover, an optical-transmission means arranges an optical fiber in in the shape of an array, and optical coupling of the aforementioned array-like light-corpuscle child is carried out to this optical fiber end face by perpendicular close outgoing radiation, and it may be fixed to it. The optical-transmission means for performing a space multiplex optical transmission and raising transmission capacity in the above-mentioned optical wiring equipment, also by this, can be offered. It is also small to use what carried out the bundle of the optical fiber to the shape of an array as an optical-transmission means, and the optical wiring mass by the low cost of it is attained.
[0020] It pastes up with a metal thin film and the aforementioned optical-transmission means changes, and while carrying out an optical transmission by forming wiring by this metal thin film, electrical connection can also be performed simultaneously. Thereby, a transmission means by which electrical installation can also be performed simultaneously can be offered. By pasting up the electric wiring pattern by the metal thin film on an optical-transmission means, electrical connection used for the signal of low frequency, connection of a power supply and a gland, etc. can also be performed simultaneously.
[0021] The electrical connector section in which desorption is possible performs electrical installation in the receptacle mounted in electronic equipment. Thereby, the connection method for performing an optical interconnection using the above-mentioned optical wiring equipment from the wiring board in electronic equipment can be offered. In this connection method, desorption can be carried out repeatedly easily and reliability is a low cost highly.
[0022] The electrical connector section in which desorption is possible performs electrical installation with soldering on the printed circuit board in electronic equipment. The connection method for this also performing an optical interconnection using the above-mentioned optical wiring equipment from the wiring board in electronic equipment can be offered. Here, it leads to ** space-ization on a printed circuit board by connecting an electrical connector with direct soldering on the printed circuit board in electronic equipment.
[0023] The drive method of the above optical wiring equipment which contains a surface emission-type laser in the light-corpuscle child who attains the above-mentioned purpose is characterized by performing adjustment of a deed and

the drive current of laser by the resistance inserted in series directly by turning on and off of the CMOS buffer of the output stage by the side of the electronic equipment by which the drive of a surface emission-type laser was connected with the current carrying part of the aforementioned electrical connector. By this, the on-off drive of the above-mentioned surface emission-type laser is performed with the transistor of output stages, such as LSI, there is no change on a special circuit, and the drive method of a low cost and the optical wiring equipment of a low power can be offered. Here, since the on-off drive of the above-mentioned surface emission-type laser is performed by switching with the transistor of output stages, such as LSI, resistance and a surface emission-type laser are connected to supply voltage in series and the amount of current of a surface emission-type laser is determined with the resistance, there is no change on a special circuit and it becomes the drive method of a low cost and the optical wiring equipment of a low power.
[0024] The electronic equipment which attains the above-mentioned purpose is characterized by connecting and constituting equipments which carried electric accumulation elements, such as a large-scale central arithmetic unit (MPU) and a RAM, such as a printed circuit board board, and other multi chip modules, storage, using above optical wiring equipment. Thereby, by using the above-mentioned optical wiring equipment within electronic equipment, high speed signal processing is possible at a low cost, and the equipment which is a low radiated noise can be offered. By making connection between the board in electronic equipment, or built-in equipment with the above-mentioned optical wiring equipment, high speed signal processing is possible, formation of a ** space of a cable and low EMI-ization can be performed, and there is an advantage, like the time and effort of a design of RF matching can be saved.
[0025] The electronic equipment which attains the above-mentioned purpose is characterized by constituting the connection between the main part in which CPU etc. is carried, and a display equipped with various I/O Ports, and/or connection with a Local Area Network using above optical wiring equipment in a computer system. Equipment and the network which can perform a mass signal transmission by the low cost by connecting electronic equipment using the above-mentioned optical wiring equipment by this can be offered. By using the above-mentioned optical wiring equipment in the main part of a computer, a display, or connection with LAN (Local Area Network), formation of a ** space of a cable and low EMI-ization can be performed, and there is an advantage, like the time and effort of a design of RF matching can be saved.
[0026]
[Embodiments of the Invention] The gestalt of concrete operation of this invention is explained to it, referring to drawing to below.
[0027] In the [1st example] this invention, the amount of connector area performs desorption using the conventional electrical connector, the conversion function of O/E and/or E/O is integrated to a plug side, the combination with a light-corpuscle child and an optical waveguide is fixed by adhesion, and it is characterized by not needing an optical connecter. Thereby, desorption is easy and it is reliable, and optical mounting parts are cut down sharply and the low cost connector for optical connection can be offered.
[0028] Drawing 1 is drawing explaining the composition for a connector area of the 1st example of this invention. In drawing 1 (a), 7 is a connector area for electrical connection, and consists of a scalpel bond part 8 and a pin 9 for electrical connection with a latter wire. Although the connector area 7 for electrical connection is easy to be the thing made of a resin used from the former and has 16 pins 9 of 2x8 in this drawing, it is easy to be arbitrary [the connector area / the number of pins], and is easy to be natural [the connector area / a bond part 8] also at a male type.
[0029] There is a plate 4 in which the circuit pattern (this combines each hole 5 and the electrode pad 9 electrically although not illustrated), and the electrode pad 6 were formed in the latter part of this connector area 7. The plate 4 is fixed to the connector area 7 by being soldered while the pin 9 of the above-mentioned connector area 7 is fitted over a hole 5. It is good by the resin by which this plate 4 is also usually used for the electric printed circuit board. Moreover, as long as it is required, you may constitute the electronic circuitry for a drive of the below-mentioned light-corpuscle child on this plate 4.
[0030] Furthermore, E/O and the O/E transducer 1 with which the light-corpuscle child and the multi-core optical waveguide 3 were united have pasted the latter part. The flexible substrates (TAB tape etc.) 18 in which the electric wiring pattern was formed perform electric wiring with a light-corpuscle child by connecting with the electrode pad 6. After assembling all, it is made to be easy to handle by hardening the whole by the wrap and the mould resin by covering (un-illustrating).
[0031] The example of the composition of E/O and the O/E transducer 1 is shown in drawing 1 (b). In the case of the E/O transducer, it is mounted in the form where a surface emission-type laser 11 is sandwiched by two plates 10 and 19, and has come to be able to do independent wiring for each element on the TAB tape 18. That is, alignment of the ring electrode 13 prepared in the surroundings of the light-emitting part 12 of a surface emission-type laser 11 and the electrode 17 of the TAB tape 18 is carried out, flip chip mounting is carried out and the aperture 14 for light transmissions is formed in the portion corresponding to each light-emitting part 12 mounted after both ring electrode 13

and electrode 17 have hidden completely between mounting planes of composition. The common electrode of a surface emission-type laser 11 may be prepared in the plate 10 side, and may be taken out to the TAB tape 18 side (about this, it mentions later). Each electrode 17 is connected to the electrode pad 15 through wiring 16, and this electrode pad 15 is connected to the electrode pad 6 formed in the plate 4.

[0032] In the multi-core optical waveguide 3, alignment is carried out and it is fixed with a plate 19 and adhesives so that optical coupling may be carried out. It can respond by the passive alignment of the grade inserted in the hole 23 which forms the guide pin 22 in the plate 10 since the allowable error of optical mounting is also about several 10 micrometers small [loss of light] again even if the thickness of a plate 19 is about 100 micrometers, when the size of a core 21 is 100-micrometer angle grade, for example, since a surface emission-type laser 11 has the outgoing radiation angle as small as 10 degrees or less, and was established in the multi-core optical waveguide 3. When using the bundle optical fiber of 50 micrometers of core diameters as an optical waveguide 3, you may raise joint efficiency by inserting a lens in a window part 14.

[0033] Moreover, for the light-corpuscle child's 11 heat leakage, as for the material of plates 10 and 19 and the TAB tape 18, what has high thermal conductivity is desirable, and it uses the polyimide film containing A12O3 powder etc. for the TAB tape 18 at plates 10 and 19 using a metal, aluminum 2O3, or an AlN ceramic thin film. Furthermore, in order to raise the heat dissipation nature from the light-corpuscle child 11, you may attach a metal membrane and a radiation fin (un-illustrating) to the adhesion side which pastes up a plate 10 on a plate 4.

[0034] Here, although explained taking the case of the E/O sensing element, in the case of an O/E sensing element, it mounts like the case of a surface emission-type laser, using pin type photo diode, a MSM (metal-semiconductor-metal) type element, etc. as a field type photo detector. The electrode of pin type photo diode is almost the same as the structure of the above-mentioned electrode, and the tandem-type electrode has come out of the electrode of a MSM type element to the same side.

[0035] In addition, although Mukai's connection, i.e., one end of an optical cable 3, on the other hand, assumes the case where another [an E/O transducer and] edge serves as an O/E transducer, in the connector described above, in preparation for the inside of both connectors, bidirectional connection is possible, both E/O and O/E are also made, and it is easy to be natural. In this case, to divide a light-corpuscle child into a surface emission-type laser 11 and the field type photo detector 24 (it has a light sensing portion 25 and an electrode 26) like drawing 2 , and what is necessary is just made to carry out flip chip mounting on the same plate 19. In this drawing, other composition is the same as that of what was already described. It is easy to be natural, even if it produces a surface emission-type laser and a field type photo detector on the same substrate and mounts the element of one apparatus like drawing 1 . Moreover, although the cable with same direction of a plug of a connector and direction of an optical cable 3 was shown, if the adhesion direction of E/O and an O/E transducer is changed like drawing 3 , it can perform making it an L type connector simply.

[0036] Next, the multi-core optical waveguide 3 for optical wiring is explained. As a material of a waveguide, it is simple to form by resins, such as fluorine-ized PMMA, and an epoxy resin, a polyimide, and it is good. Drawing 4 is explained for the production method briefly [origin].

[0037] First, it is formation **** about the resist 44 which carried out patterning to the waveguide configuration with phot lithography after forming similarly the layer 43 with the refractive index high a little which is made to harden the resin 42 used as clad after an application by the spinner etc., and serves as a core further on the Si substrate 41, as shown in drawing 4 (a).

[0038] Next, a resist 44 is removed, after forming a waveguide pattern by reactive ion etching (RIE) using oxygen plasma, as shown in drawing 4 (b). Furthermore, as shown in drawing 4 (c), it forms so that the resin 42 used as clad may be embedded, and flattening of the front face is carried out by etchback.

[0039] As shown in drawing 4 (d), the core layer 43 is formed in an optical-waveguide configuration still more nearly similarly. At this time, the position of the up-and-down waveguide 43 can be doubled with a sufficient precision by the doubling mark of a mask. And as shown in drawing 4 (e), flattening is formed and carried out so that the resin 42 which serves as clad similarly may be embedded.

[0040] If the metal thick film 20 is formed on the last clad layer 42 and wet etching, such as mechanical polishing and KOH, finally removes the Si substrate 41 as shown in drawing 4 (f), a flexible multi-core optical waveguide as shown with the sign 3 of drawing 1 is producible.

[0041] At this time, the cross section of a core 43 was 100micrometerx80micrometer, the upper and lower sides are located in a line in 250-micrometer pitch, and the metal layer 20 used as the last support substrate was made into 100 micrometers in thickness with copper. The method of forming by plating and pasting up a copper thin film is sufficient as this metal layer 20, and it is not what also restricted material to this. Thus, if the metal layer 20 is formed, not only the function of support of an optical waveguide 3 but a light-corpuscle child's function of heat dissipation can also be

given. Moreover, if it uses for connecting the electric common line between boards or forms the metal layer 27 as a circuit pattern like drawing 5 in using within equipment, electrical installation can also be performed simultaneously. This can be used as connection, an electric supply line, etc. of a comparatively late signal or an analog signal. In this case, the number of the pins 9 of a connector area 7 will be increased, and wiring which connects with this electric wiring at the part will be formed.

[0042] On the other hand, as a material of a waveguide, it may be in others variously, and the thing using the silica glass as a low loss material may be used. In this case, if the silica glass (PSG) which doped P is used, since surface flattening of the mast lance port can be occurred and carried out by heating, it is easy to produce as a multilayer light wiring layer. At this time, if refractive-index control is performed by GPSG which doped germanium further as a core layer 21, an optical waveguide can be constituted.

[0043] Next, the surface emission-type laser used for E/O conversion is explained. Usually, on n substrate, a surface emission-type laser grows epitaxially the structure which sandwiched the resonator containing a barrier layer by the DBR (Distributed Bragg Reflector) mirror, is the thing in which the constriction structure where current could be passed only to a light-emitting part was formed, and can carry out [two dimensional array]-izing like the sign 11 of drawing 1 (b) simply. Here, AlAs/AlGaAs multilayer EPIMIRA was grown up on the GaAs substrate, and the surface emission-type laser of 830nm band with the multiplex quantum well barrier layer of GaAs/AlGaAs was used. In this case, a common electrode becomes a cathode and the electrode 13 for carrying out an independent drive has become an anode.

[0044] The conceptual diagram of the E/O transducer for driving this surface emission-type laser is shown in drawing 8 (b). Although the CMOS buffer inverter 81 is constituted by the last stage of LSI connected with the pin 9 of a connector area 7 so that a current drive can be performed, in this invention, instead of connecting by the metal cable, without changing the composition of this last stage, E/O conversion is carried out by the surface emission-type laser, and it connects by the optical waveguide 3. Although the drive current capacity of a CMOS buffer is usually 10mA or less, since the threshold is very low, as for the surface emission-type laser used here, it can drive enough the operating current at the time of about 1mA and 100microW output with 3mA. Since the operating voltage when passing 3mA current to a surface emission-type laser 82 is about 2.5V, in 3.3 V-CMOS, it should just insert the resistance R of (3.3-2.5) / 3x10-3=267ohm as series resistance R. What is necessary is just to insert this resistance during wiring of the plate 4 in drawing 1 (un-illustrating).

[0045] however -- this system -- a cathode -- it is common, and in order to make it operate, a current drive will be carried out by the p channel of CMOS, and in order that the switching time may be effective, there is a limitation in improvement in the speed Since CMOS which carries out a current drive by the n channel MOS can be chosen on the other hand if it is made an anode common type like drawing 8 (a), there is a merit which can attain further improvement in the speed. Therefore, in this invention, n substrate of a surface emission-type laser is removed, and the technology made anode common by carrying out electrode separation is also developing the n side. The production method is shown in drawing 6 .

[0046] Drawing 6 </A> shows the cross section of the array of two surface emission-type lasers for simplification. In drawing 6 (a), after growing up n-GaAs (un-illustrating) used as the n-AlAs layer (un-illustrating) which turns into a dirty stop layer on the n-GaAs substrate 60, and a contact layer, the n-AlAs/AlGaAs multilayer mirror 61, the one-wave resonator layer 62 which consists of the GaAs/AlGaAs multiplex quantum well barrier layer and AlGaAs layer of undoping, and the p-AlAs/AlGaAs multilayer mirror 63 are grown epitaxially by the organic-metal vapor growth etc. Then, in order to form the current constriction layer 66, after etching in the shape of a ring and forming a crevice 67, the insulator layers 64, such as SiNx, are formed except for the luminescence field section, and an electrode 65 is formed.

[0047] Next, in drawing 6 (b), after pasting up the electrode 65 whole by the side of p on the whole surface electrode (un-illustrating) of a plate 10 with an AuSn pewter, polish and chemical etching remove the GaAs substrate 60. At this time, etchant can stop etching in the AlAs layer in which the mixed liquor of H2O2 and NH3 is used, and it has grown up on the GaAs substrate 60. Then, the GaAs layer which removes an AlAs layer and has grown to be the mirror 61 lowest side by HCl immediately is exposed. Then, in drawing 6 (c), wet etching of the portion between elements of the mirror layer 61 exposed to a front face is carried out by the etchant of a sulfuric-acid system etc., the separation slot 68 is formed, and the electrode 13 by the side of n is formed, forming a window part 12.

[0048] Next, surrounding electrode [of the hole 14 of the TAB tape 18 stuck on another plate 19] 17 and electrode of surface emission-type laser 13 comrade is too pasted up with an AuSn pewter etc. Then, the anode common type side luminescence laser which can take out light from a window part 14 is producible. What is necessary is to carry out alignment of this so that optical coupling may be performed to the core 21 of the multi-core optical waveguide 3, and just to paste up the end face of a plate 19 and a waveguide 3.

[0049] Moreover, there is also a method like drawing 7 by the difference of the some of the production method. In this case, composition differs drawing 1 and a little and the TAB tape 18 for wiring has structure which comes out of the

plate 10 of the opposite side of an optical waveguide 3. In drawing 7 (a), although field luminescence laser structure is produced like the case of drawing 6 (a), in order to take out light from p mirror layer 63 side, the aperture 70 for optical ejection is opened in the electrode 65. Moreover, the p side is stuck on the quartz-glass board 69 with an electron wax etc.

[0050] In drawing 7 (b), the GaAs substrate 60 is removed like the case of drawing 6 (b), and an electrode 71 is formed. At this time, the through hole electrode 74 is formed in a field without a light-emitting part with an insulating layer 75, and the anode electrode which is a pad 76 is produced to the same side as a cathode electrode so that the p electrode 65 used as a common electrode can also be taken out from the same side. And the TAB tape 18 is stuck on a plate 10, and the electrodes 72 and 73 on a TAB tape, the cathode electrode 71 of laser, and the common anode electrode 76 are pasted up on it, respectively. At this time, in order that light may not take out from the side here, it is not necessary to open an aperture in electrodes 71 and 72. The p side is stuck on the above-mentioned quartz-glass board 69 in order to make these work easy to do.

[0051] In drawing 7 (c), the quartz-glass board 69 is removed, and after carrying out alignment so that optical coupling of the electrode 65 by the side of this may be carried out to the core 21 of an optical waveguide 3, the end face of an optical waveguide 3 is pasted. In this example, since the laser outgoing radiation section and the core 21 are close, joint loss of light becomes very small.

[0052] Thus, with the composition which removed the GaAs substrate 60, since As content can be sharply lowered while the stratum functionale which oscillates a laser beam is thin and an E/O transducer becomes very compact, environmental safety also becomes high. Moreover, since this function part is inserted into the two structures 10 and 19 with the gestalt of drawing 6 , if the thermally conductive high matter is used for these structures, a laser property can be improved more.

[0053] By the way, although light emitting diode can also be used as a field type light emitting device, while 1 figure of operating currents becomes large with about 30mA and power consumption becomes high, the device of a driver portion is needed. Moreover, although a field type photo detector was not described in detail, composition and the production method are similar, are grown epitaxially and diffused and are producing the pin structure of GaAs. Si and InGaAs are sufficient as material. In a MSM type case, you should just form the Kushigata electrode with aluminum etc. on GaAs. What is necessary is just to constitute such an electronic circuitry on the plate 4 which formed wiring of the connector area 7 latter part as stated above etc., since amplifier and a distinction circuit are needed for the drive circuit of a photo detector.

[0054] Moreover, although the example of 830nm band was shown here, other wavelength ranges, i.e., 0.98-micrometer band by InGaAs, and 1.3-micrometer band by InGaAsP are also easy to be natural.

[0055] In the 1st example of [the 2nd example], although it was a connector for optical wiring in the case of mainly using for parallel wiring, if the number of pins increases, the area which a connector area occupies, and the volume of a multi-core optical waveguide will become large.

[0056] Then, in this example, while making the one section serial and decreasing the number of pins, the high-speed transmission which is a light-corpuscle child's feature is used. In this example, the connector pin (male) 91 is being fixed to the base plate 90 like drawing 9 (a), and it connected with the board by the scalpel connector 98 mounted on the board 100 like drawing 9 (b), or like drawing 9 (c), it soldered to the direct board 100 (a sign 103 shows), and has connected with it. There is a bare chip 92 of Si-IC with which IC for parallel-serial conversion and IC for a laser drive were accumulated in the latter part of a base plate 90, flip chip mounting is carried out and the stack of the field type light-corpuscle child 93 (in drawing 9 (a), it is perspective drawing) is carried out to this LSI. Furthermore, alignment was carried out and it has pasted up so that the light-corpuscle child 93 and the optical waveguide 95 of the multi-core 94 may carry out optical coupling, and the termination socket 96 which becomes covering-cum-handling has pasted the optical waveguide 95.

[0057] Next, the composition of Si-IC92 and the light-corpuscle child 93 is explained. It is drawing 10 which showed the cross section of the portion of a surface emission-type laser. A sign 92 is Si-IC explained above, by drawing 10 , although not shown, is mounted on a base plate 90 and is electrically connected with a pin 91. The field where the light-corpuscle child 93 is mounted is established in Si-IC92, and it minds wiring 106 and connects with the electrode of IC92. Like drawing 10 , alignment of the electrodes 71 and 76 is carried out, and flip chip mounting of this wiring 106 and the field type light-corpuscle child 93 is carried out.

[0058] The cross section of the field type light-corpuscle child 93 shown in drawing 10 is the same as the surface emission-type laser of drawing 7 shown in the 1st example. In drawing 10 , it is shown that the same thing as the sign of drawing 7 is the same function part. However, having the ceramic plate 105 for raising thermal conductivity to that the TAB tape 18 is unnecessary and an adhesion side with an optical waveguide 95, and reinforcing the light-corpuscle child 93 only differ. Here, although the sign 92 considered as Si-IC, when serial-parallel conversion is unnecessary, it is

used as a mere wiring substrate. Moreover, although illustrated taking the case of the surface emission-type laser, a field type photo detector is mounted similarly, and when it has four cores 94 by 2x2 as shown in drawing 9 (a), you may carry out two field type photo detectors to a surface emission-type laser all the time.

[0059] Next, the connection method to a board 100 is explained in more detail based on drawing 9 (b) and (c). Drawing 9 (b) is the case where a socket 98 is prepared for a board 100, and flat-spring-like a spring 99 and a pin 91 are connected. The pin 101 from a socket 98 is soldered to the board 100 (a sign 102 shows). Drawing 9 (c) is the case where omit a socket and the direct connector pin 91 is soldered to a board 100 (103). In this case, a pin 91 is good also as a flat type of the type out of which a pin comes in parallel with a base plate 90 so that a surface mount may be made.

[0060] Moreover, in the cross section of drawing 9 (b) and (c), 97 is the reinforcement given after carrying out the stack of a base plate 90, Si-IC92, the light-corpuscle child 93, and the optical waveguide 95, and the member which served both as covering, and is omitted by drawing 9 (a). On the other hand, the optical waveguide 95 of the multi-core 94 may be the same as that of the 1st example, and when there are few cores, it is good also as an optical waveguide of a one dimensional array. The array fiber which arranged the optical fiber in the shape of-dimensional [1], of course is sufficient. Thus, when it is made a one dimensional array, you may use the waveguide type device which performs luminescence and light-receiving from an end face as a light-corpuscle child.

[0061] As mentioned above, the example of the whole image constituted using the 1st and an optical wiring element like the 2nd example is shown in drawing 11 . In drawing 11 , as for 30, the mother board 30 is equipped with the MCM module [memory / primary KYASHU] with which large-scale arithmetic and program control (MPU) and 31 were carried, and, as for 33, DRAM was carried as a daughter board, as for the mother board as a photoelectricity mixed-loading substrate, and 32. Although the signal transmission in a board 30 and 33 is performed by wiring 34, in the case of a high speed signal, it is good also as an optical waveguide in part. It connects using the connector 35 with optical built-in-electrical-and-electric-equipment conversion and the multi-core optical waveguide 36 of the 1st example according to this invention in parallel connection between boards. An optical waveguide 36 is easy desorption, when volume was small, and wiring becomes high-density compared with the conventional electric wiring, since flexibility is also high. Moreover, since there is no interference of the electromagnetic wave in a wiring portion and there is no need for impedance matching for a connector area 35 while the radiated noise from the problem and equipment of a cross talk is reduced, a design becomes easy.

[0062] Carrying out serial fast transmission of the exchange of a signal with external storage like a hard disk drive using the connector 38 and the multi-core waveguide 37 of the 2nd example by this invention may lead to low-cost-ization of a cable. The connector area 38 is equipped with the transceiver section which carries out parallel-serial conversion and has the transfer rate of about 10Gbps. In drawing 11 , although only the main portions of a board are written, it can be made required circuitry, connection between boards and connection between the built-in electronic equipment in equipment can be made with the optical wiring by this invention, and a clock rate can constitute a next-generation computer exaggerated 1GHz.

[0063] Compared with using a LVDS method at this time, a miniaturization and low-power-izing are possible at high speed, and the cure against EMI can offer easy optical wiring. It is advantageous in respect of the reliability of the desorption of a cost cable, ease, etc. also to the optical interconnection using the conventional optical connecter. Moreover, not only in a computer but in the latest electronic equipment, for example, a cellular phone, and a digital camera, improvement in the speed and the miniaturization are demanded more, and since the reduction in EMI is simultaneously indispensable, the optical wiring by this invention becomes very effective in these devices.

[0064] The [3rd example] Although the multi-core waveguide produced in a surface process was used as an optical waveguide, if the length of wiring is set to 1m or more like connection between equipment, it constituted using the optical fiber, and it is [direction] advantageous in respect of total cost, and a connector consists of the 1st and the 2nd example at this example using an array fiber.

[0065] The perspective diagram which explains the part composition to drawing 12 is shown. The electrical connector section 120 is equipped with the pin 121 for electrical connection, and flip chip mounting of Si-IC122 is carried out so that it may connect with the pin 121.

[0066] The drive IC of a surface emission-type laser and the drive IC of a field type photo detector are integrated by Si-IC122 like the 2nd example. A part of the IC122 has the space and electrode pad with which the light-corpuscle child 123 is mounted like the 2nd example, and on IC122, the light-corpuscle child 123 also does flip chip mounting, and is stack-ized. Even if the light-corpuscle child 123 consists of surface emission-type laser and field type pin-PD and is formed on the same substrate, what produced separately, carried out flip chip mounting in hybrid, and was unified on the same Si-IC is satisfactory for him. What is necessary is just to perform stack-ization with this Si-IC122 and the light-corpuscle child 123 like the 2nd example. Mounting becomes complicated although the end-face luminescence laser which may not necessarily be a field type element and has the short resonator of a low threshold may be used.

[0067] Moreover, as an optical waveguide 130, four array fibers 127 and 128 were used in 250-micrometer pitch. Although GI(graded index)-50 were used as a fiber, a single mode fiber and a plastic optical fiber (POF) are sufficient. Especially the HPCF fiber of a plastic has the merit that clad 127 is [a core 128] 200 micrometerphi grade in a quartz for a core 128, and optical coupling is easy and moreover low loss among POF(s), and the merit which can carry out [low cost]-izing.
[0068] The array of a fiber arranges a fiber in the Si substrate 126 in which the V groove was formed, like drawing 12 , and can produce it with a sufficient precision easily only by pressing down a fiber by the flat Si substrate 125 from a top, and fixing with adhesives. The reinforcing materials 129 which served as handling are pasted up on the point of this array fiber 130, and the end face is ground. And alignment is carried out so that optical coupling can do the light-corpuscle child's 123 carrier and light-emitting part 124, and fiber which were stack-ized by IC122 described above, and the end face of reinforcing materials 129 is pasted up on the light-corpuscle child 123. A connector with photoelectrical converter ability is completed by pasting up the covering member (un-illustrating) which served as reinforcement further between a connector 120 and reinforcing materials 129, or hardening the whole by mould material.
[0069] With this equipment, since the optical fiber is used, a transmission distance can be freely chosen to 100m or more. since [moreover,] it is an optical transmission -- electromagnetism -- there are not mixing of a noise and radiation and there is also no need for impedance matching in a connector area Moreover, since there is no optical coupling section in a connector area, it is reliable, and there is also no danger at the time of desorption.
[0070] Such optical wiring can be used for transmission between the high-speed electronic equipment by IEEE1394 of the next generation, the Ethernet work of the Gbit class between computers, etc. The example is shown in drawing 13 .
[0071] In drawing 13 , the main part 133 of a pancontest is connected with the liquid crystal display 134 with the optical wiring 132 by this invention. The IEEE1394 port 142 which connects the ports (USB etc.) 141 which can connect a keyboard 137 and external storage 140, and digital video equipment 139 is established in the front face of a liquid crystal display 134, and wiring is connected to it here. A mouse 138 is infrared radiation and is spatially connected to the sensor 143 with which the front face of a liquid crystal display 134 was equipped too. Although such composition is an example of connection of the personal computer currently developed to the next generation, if a connection port is established in the front face of a display in order to think a user interface as important, high-speed transmission will be required between a main part 133 and a display 134. If the light wiring with an electrical connector by this invention is used for the portion of wiring 132 here, it is realizable of connection which can be transmitted at high speed by the low cost and low EMI. Here, since the optical connecter is not used for a connector area, a general consumer becomes the optical wiring which can be treated easily.
[0072] On the other hand, if the optical distribution cable 135 by this invention is used in order to require connection of a GIII class also about connection with a hub 136, or connection with LAN, low-cost-izing of a cable, the reduction in a weight, and ** space-ization can be built with sufficient reliability. Although all connector areas were equipped only with the pin for obtaining electric contact in the above example, you may be the photoelectricity mixture connector which made the optical connecter for making optical connection in part intermingled.
[0073]
[Effect of the Invention] As explained above, when making optical connection using the optical fiber or the optical waveguide by this invention, desorption is easy, it is reliable, and the optical interconnection which can be performed through the electrical connection by the low cost electrical connector section can be realized. Moreover, since small, the low cost electrical and electric equipment, and an optical mounting means are realizable by surface mounting, the connector for performing an optical interconnection can be miniaturized.
[0074] Moreover, the on-off drive of a surface emission-type laser is performed with the transistor of the output stage of LSI, there is no change on special LSI or an electrical circuit, and the drive method of a low cost and the optical wiring equipment of a low power can also be offered. Furthermore, by using the above-mentioned optical wiring equipment within electronic equipment, by the low cost, high speed signal processing is possible and the equipment which is a low radiated noise can be offered. Moreover, equipment and the network which can perform a mass signal transmission by the low cost can be offered by connecting electronic equipment using the above-mentioned optical wiring equipment.

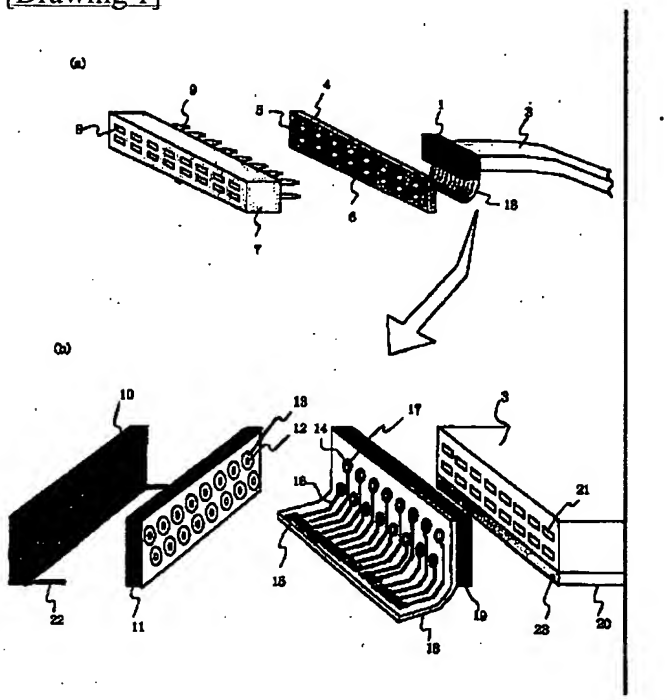
[Translation done.]

* NOTICES *

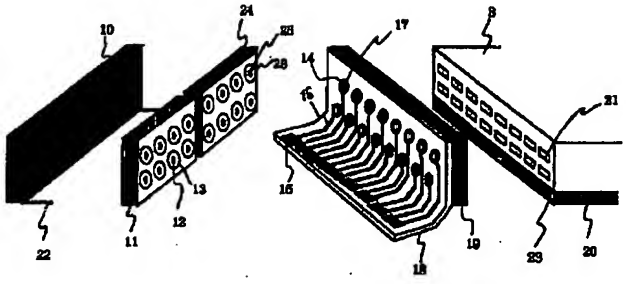
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

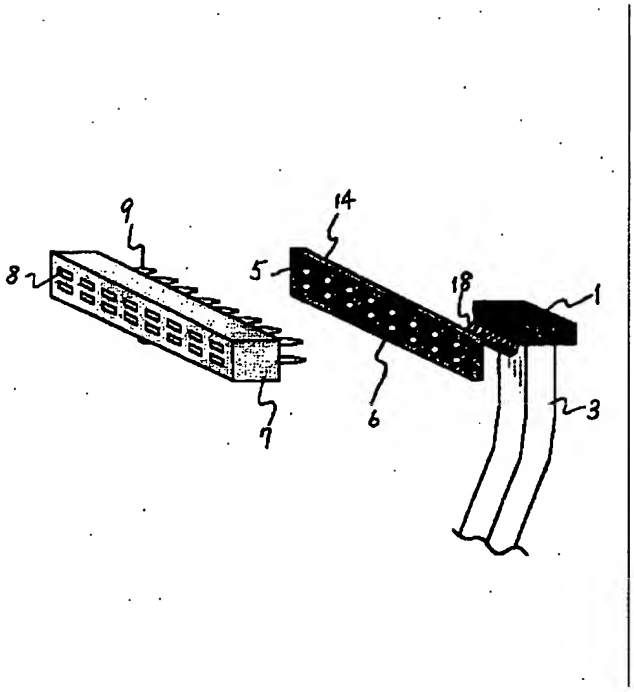
[Drawing 1]



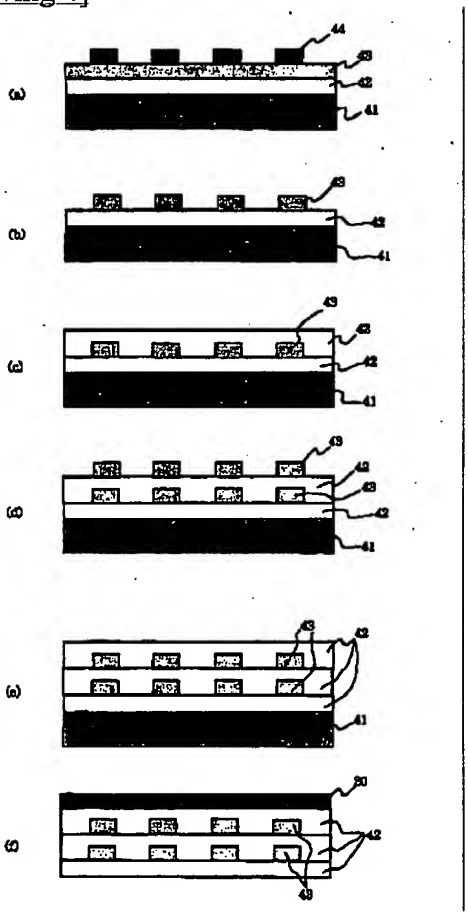
[Drawing 2]



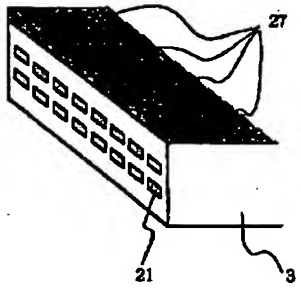
[Drawing 3]



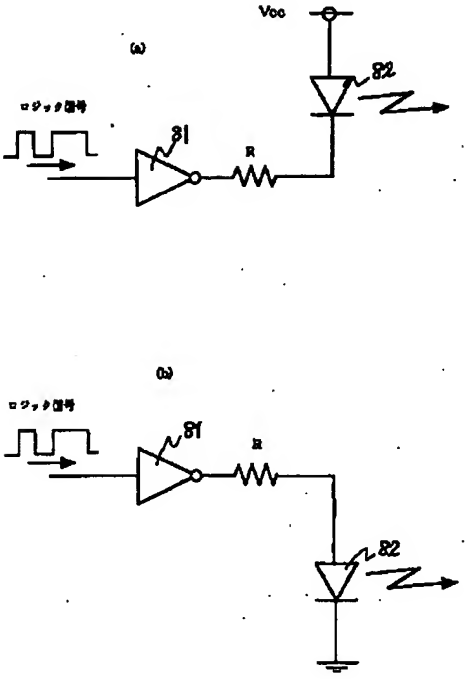
[Drawing 4]



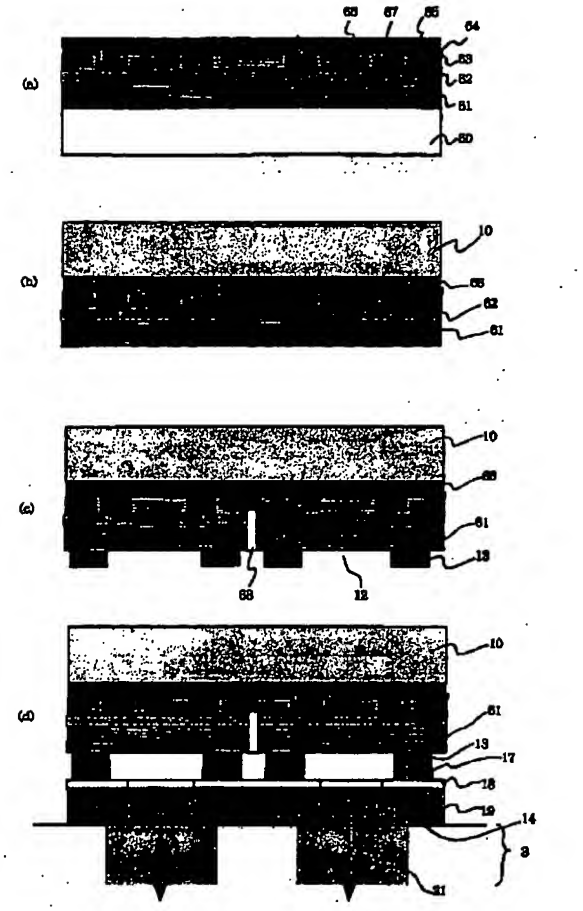
[Drawing 5]



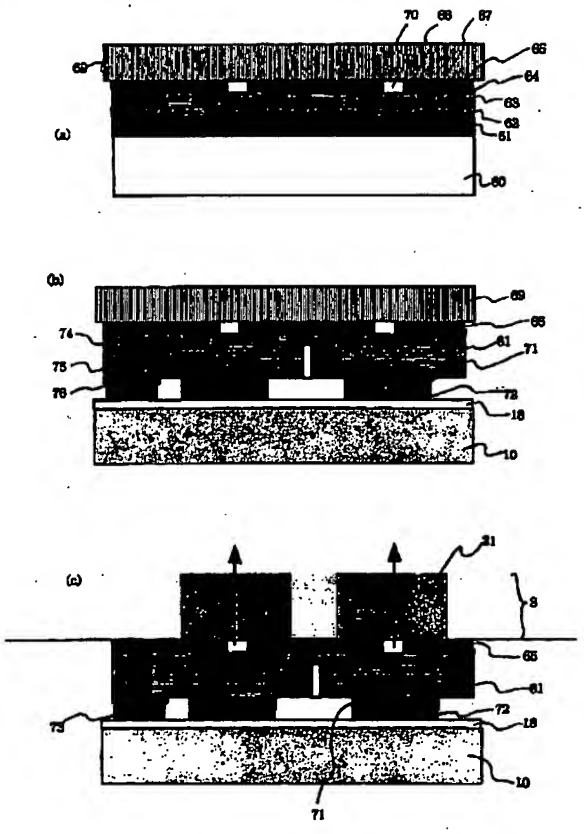
[Drawing 8]



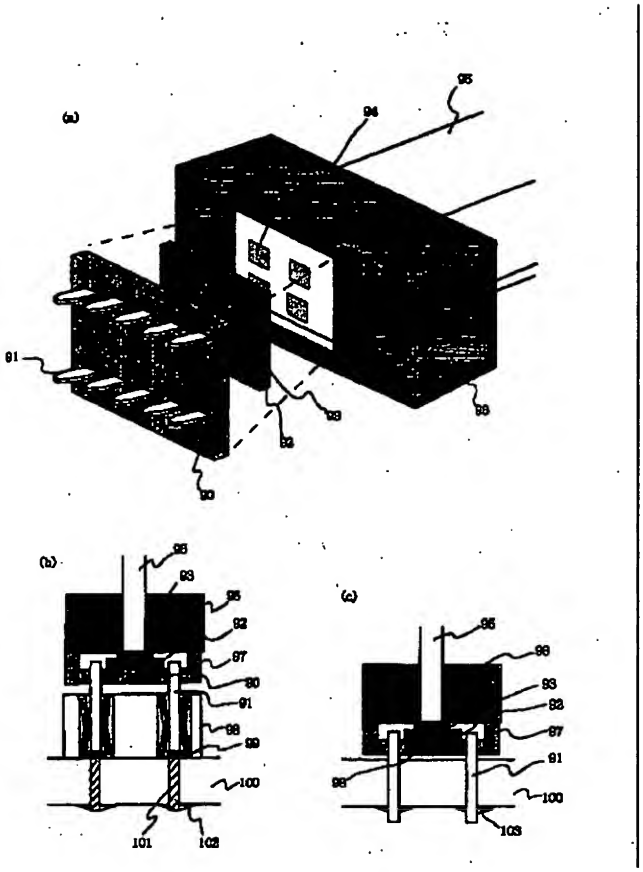
[Drawing 6]



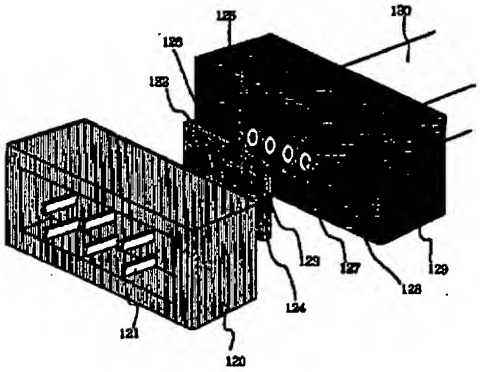
[Drawing 7]



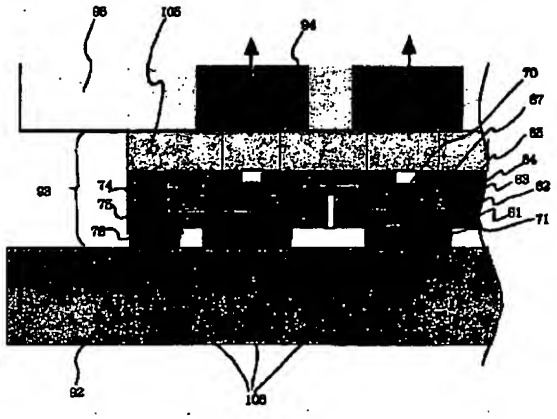
[Drawing 9]



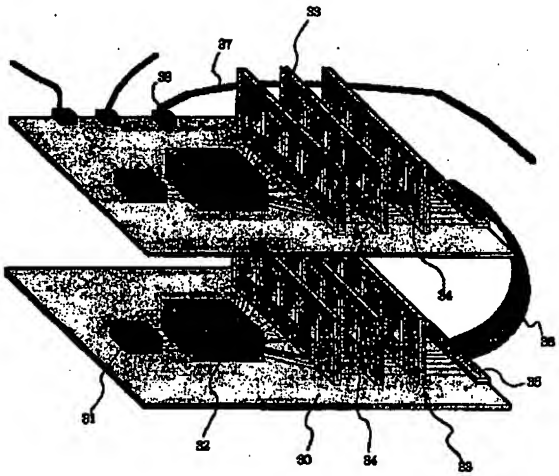
[Drawing 12]



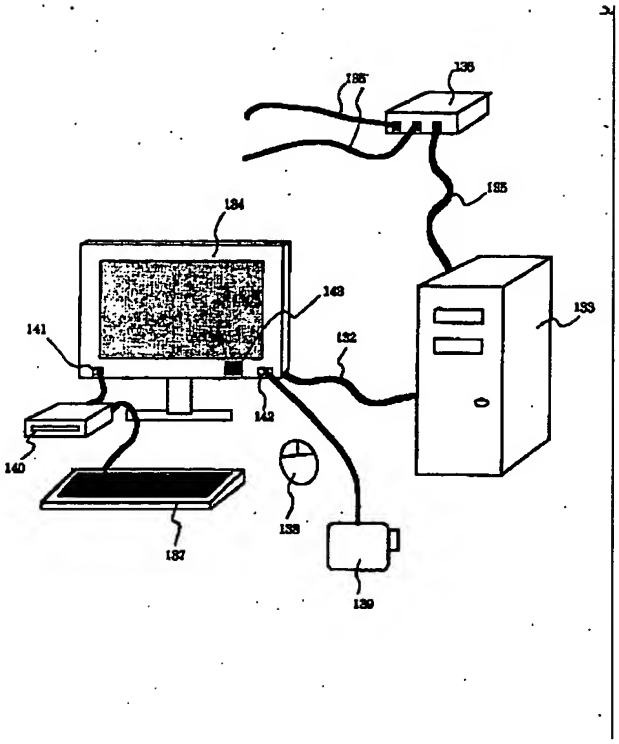
[Drawing 10]



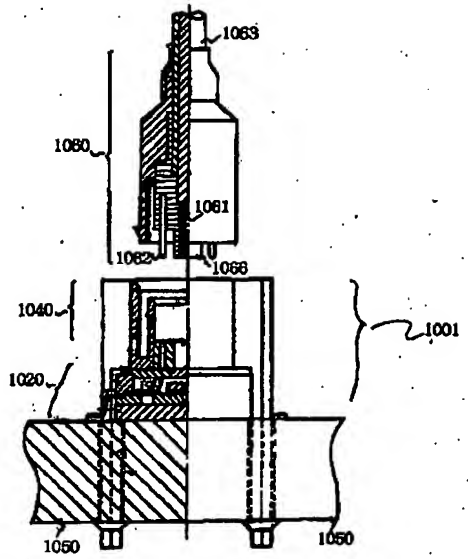
[Drawing 11]



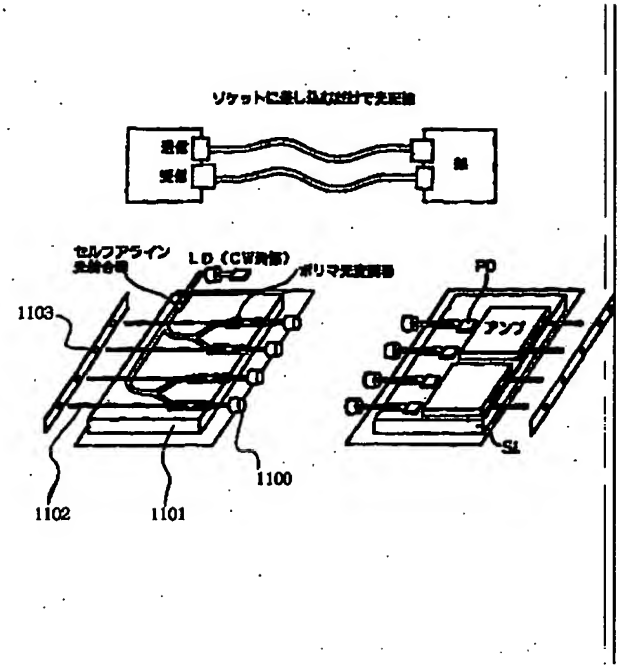
[Drawing 13]



[Drawing 14]



[Drawing 15]



[Translation done.]

* NOTICES *

CORRECTION or AMENDMENT

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[Date of issue] April 10, Heisei 14 (2002. 4.10)

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31/12
H01R 13/46
H01S 5/022
5/18
H04B 10/14
10/135
10/13
10/12

[FI]

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G06F 3/00 E
H01L 31/12 G
H01R 13/46 D
H01S 5/022
5/18
G06F 1/00 320 E
H01L 31/02 C
H04B 9/00 Q

[Procedure revision]
[Filing Date] December 10, Heisei 13 (2001. 12.10)
[Procedure amendment 1]
[Document to be Amended] Specification
[Item(s) to be Amended] Claim
[Method of Amendment] Change
[Proposed Amendment]
[Claim(s)]
[Claim 1] It is a distribution cable for the signal connection between electronic equipment or in electronic equipment. The electrical connector section in which desorption is possible between the exteriors, It has a light-corpuscle child for carrying out photo electric translation to an optical-transmission means by which a lightwave signal can be transmitted.

this light-corpuscle child The light emitting device modulated by the electrical signal connected by the current carrying part of the electrical connector section in which this desorption is possible, It is optical wiring equipment characterized by carrying out alignment of this light-corpuscle child, and being fixed so that it may consist at least of one side of the photo detector which changes the lightwave signal transmitted with this optical-transmission means into the electrical signal for connecting with the current carrying part of this electrical connector section, it may integrate and optical coupling may be carried out to this optical-transmission means.

[Claim 2] It is optical wiring equipment according to claim 1 which a light-corpuscle child is a field ON outgoing radiation type field type semiconductor light-corpuscle child, and is characterized by for this light-corpuscle child making fields contact the optical ON outgoing radiation edge of an optical-transmission means, and carrying out surface mounting.

[Claim 3] It is optical wiring equipment according to claim 2 characterized by a light emitting device being a surface emission-type laser among light-corpuscle children.

[Claim 4] It is optical wiring equipment according to claim 2 characterized by a photo detector being pin type photo diode or a MSM type element among light-corpuscle children.

[Claim 5] A light-corpuscle child is optical wiring equipment given in the claim 1 or any of 4 they are. [which is characterized by being arranged in the shape of an array, sticking the independent electrode of each element on a wiring substrate by flip chip mounting, being fixed to the structure prepared in the aforementioned electrical connector section, and wiring independently of each current carrying part of the electrical connector section]

[Claim 6] A light-corpuscle child is optical wiring equipment according to claim 5 characterized by having pasted up by surface mounting so that the aperture for optical ejection may be prepared in the aforementioned wiring substrate or the structure and the optical coupling of it can be carried out to the aforementioned optical-transmission means.

[Claim 7] The wiring substrate used for the electrical connection of a light-corpuscle child and each current carrying part of the electrical connector section is optical wiring equipment according to claim 5 or 6 characterized by being the flexible wiring substrate which can be bent freely.

[Claim 8] Optical wiring equipment given in the claim 1 or any of 7 they are. [to which the electronic-circuitry element for driving a light-corpuscle child is characterized by the aforementioned electrical connector section integrating simultaneously]

[Claim 9] Optical wiring equipment according to claim 8 characterized by including a parallel-serial conversion function in an electronic-circuitry element.

[Claim 10] Optical wiring equipment given in the claim 1 or any of 9 they are. [which is characterized by preparing the electronic-circuitry element which hybridized the aforementioned light-corpuscle child's bare chip on this Si substrate by direct flip chip mounting so that IC and electric contact which were integrated on same Si substrate might be obtained]

[Claim 11] The light-corpuscle child who is a surface emission-type laser is optical wiring equipment given in the claim 5 or any of 10 they are. [which is characterized by being mounted in the form sandwiched between the aforementioned structure or an optical-transmission means, and a wiring substrate, leaving only a multilayer reflective mirror and the resonator layer containing a barrier layer, and removing and constituting the semiconductor substrate]

[Claim 12] An optical-transmission means is optical wiring equipment given in the claim 1 or any of 11 they are. [which is the things of the shape of a sheet with which the optical waveguide was produced using phot lithography and etching, and the core was compared in the shape of an array, and is characterized by carrying out optical coupling of the aforementioned array-like light-corpuscle child to this optical-waveguide end face, and fixing him to it by perpendicular close outgoing radiation]

[Claim 13] An optical-transmission means is optical wiring equipment given in the claim 1 or any of 11 they are. [which is characterized by arranging an optical fiber in the shape of an array, carrying out optical coupling of the aforementioned array-like light-corpuscle child to this optical fiber end face, and fixing him to it by perpendicular close outgoing radiation]

[Claim 14] The aforementioned optical-transmission means is optical wiring equipment according to claim 12 or 13 characterized by performing electrical connection simultaneously while carrying out an optical transmission by pasting up with a metal thin film, changing and forming wiring by this metal thin film.

[Claim 15] The electrical connector section in which desorption is possible is optical wiring equipment given in the claim 1 or any of 14 they are. [which is characterized by performing electrical installation in the receptacle mounted in electronic equipment]

[Claim 16] The electrical connector section in which desorption is possible is optical wiring equipment given in the claim 1 or any of 14 they are. [which is characterized by performing electrical installation with soldering on the printed circuit board in electronic equipment]

[Claim 17] It is the drive method of the optical wiring equipment characterized by performing adjustment of a deed and the drive current of laser by the resistance inserted in series directly in the drive method of optical wiring equipment given in the claim 1 or any of 16 they are by turning on and off of the CMOS buffer of the output stage by the side of the electronic equipment by which the drive of a surface emission-type laser was connected with the current carrying part of the aforementioned electrical connector. [which contains a surface emission-type laser in a light-corpuscle child]

[Claim 18] Electronic equipment characterized by connecting and constituting equipments which carried the electric accumulation element, such as a printed circuit board board, and other multi chip modules, storage, using optical wiring equipment given in any [a claim 1 or] of 16 they are.

[Claim 19] Electronic equipment characterized by constituting the connection between the main part in which CPU is carried, and a display equipped with various I/O Ports, and connection with a Local Area Network in a computer system using optical wiring equipment given in any [a claim 1 or] of 16 they are.

[Claim 20] It is optical wiring equipment characterized by being an electric lines or cable, a light-corpuscle child for carrying out photo electric translation, and optical wiring equipment that has an optical-transmission means, and fixing this light-corpuscle child and this optical-transmission means so that optical coupling may be mutually carried out within this optical wiring equipment.

[Claim 21] The aforementioned electric lines or cable is optical wiring equipment according to claim 20 characterized by being what connects this optical wiring equipment and a device possible [desorption].

[Claim 22] The aforementioned light-corpuscle child is optical wiring equipment according to claim 20 or 21 characterized by being a field type light-corpuscle child.

[Translation done.]

* NOTICES *

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[Proposed Amendment]
[Claim(s)]
[Claim 1] It is optical wiring equipment which it is an electric lines or cable, the light-corpuscle child who performs photo electric translation, and optical wiring equipment which has an optical-transmission means, this light-corpuscle child and this optical-transmission means are being fixed so that optical coupling may be mutually carried out within

this optical wiring equipment, and is characterized by constituting the aforementioned light-corpuscle child including a field type light emitting device and pin type photo diode, or a MSM type photo detector.

[Claim 2] It is optical wiring equipment characterized by being an electric lines or cable, a photoelectrical transducer, and optical wiring equipment that has an optical-transmission means, fixing this photoelectrical transducer and this optical-transmission means so that optical coupling may be mutually carried out within this optical wiring equipment, and for this photoelectrical transducer consisting of two or more field type light-corpuscle children, and carrying out flip chip mounting of this field type light-corpuscle child's independent electrode.

[Claim 3] Optical wiring equipment according to claim 2 with which the flexible substrate or the TAB tape is used for the aforementioned flip chip mounting.

[Claim 4] It is optical wiring equipment characterized by being an electric lines or cable, a photoelectrical transducer, and optical wiring equipment that has an optical-transmission means, and fixing this photoelectrical transducer and this optical-transmission means so that optical coupling may be mutually carried out within this optical wiring equipment, and for this photoelectrical transducer consisting of two or more field type light-corpuscle children, and integrating and arranging this photoelectrical transducer between this optical-transmission means and this electric lines or cable.

[Claim 5] It is optical wiring equipment which is an electric lines or cable, a photoelectrical transducer, and optical wiring equipment that has an optical-transmission means, and is characterized by to arrange IC by which this photoelectrical transducer and this optical-transmission means were fixed so that optical coupling might be mutually carried out within this optical wiring equipment, this photoelectrical transducer consisted of two or more field type light-corpuscle children, and the drive circuit of this photoelectrical transducer was integrated between this optical-transmission means and this electric lines or cable.

[Claim 6] It is optical wiring equipment which is an electric lines or cable, a photoelectrical transducer, and optical wiring equipment that has an optical-transmission means, and is characterized by to arrange IC by which this photoelectrical transducer and this optical-transmission means were fixed so that optical coupling might be mutually carried out within this optical wiring equipment, this photoelectrical transducer consisted of two or more field type light-corpuscle children, and this photoelectrical transducer and its drive circuit were integrated between this optical-transmission means and this electric lines or cable.

[Claim 7] It is optical wiring equipment which it is an electric lines or cable, the light-corpuscle child who performs photo electric translation, and optical wiring equipment which has an optical-transmission means, this light-corpuscle child and this optical-transmission means are being fixed so that optical coupling may be mutually carried out within this optical wiring equipment, and is characterized by constituting the aforementioned light-corpuscle child including the field type light emitting device equipped with the multilayer reflective film mirror.

[Claim 8] It is optical wiring equipment which is an electric lines or cable, the light-corpuscle child who performs photo electric translation, and optical wiring equipment which has an optical-transmission means, and is characterized by to fix this light-corpuscle child and this optical-transmission means so that optical coupling may be mutually carried out within this optical wiring equipment, to constitute the aforementioned light-corpuscle child including a field type light-corpuscle child, and to form metal wiring in the aforementioned optical-transmission means.

[Claim 9] The aforementioned metal wiring is optical wiring equipment according to claim 8 by which patterning is carried out.

[Claim 10] This electric lines or cable that has an electric lines or cable, the light-corpuscle child who performs photo electric translation, and an optical-transmission means and that it is optical wiring equipment, this light-corpuscle child and this optical-transmission means are fixed so that optical coupling may be mutually carried out within this optical wiring equipment, the aforementioned light-corpuscle child is constituted including a field type light-corpuscle child, and is located in one edge of the aforementioned optical-transmission means is optical wiring equipment characterized by to be soldered to the printed circuit board in electronic equipment.

[Claim 11] It is optical wiring equipment which it is an electric lines or cable, the light-corpuscle child who performs photo electric translation, and optical wiring equipment which has an optical-transmission means, this light-corpuscle child and this optical-transmission means are fixed so that optical coupling may be mutually carried out within this optical wiring equipment, this light-corpuscle child is constituted including a field type light-corpuscle child, and is characterized by to be carried out using the CMOS buffer of the electronic equipment by which a drive of this light-corpuscle child is connected to this electric lines or cable.

[Claim 12] It is optical wiring equipment characterized by being an electric lines or cable, the light-corpuscle child who performs photo electric translation, and optical wiring equipment which has an optical-transmission means, fixing this light-corpuscle child and this optical-transmission means so that optical coupling may be mutually carried out within this optical wiring equipment, and constituting this light-corpuscle child including a field type light-corpuscle child, and the aforementioned electric lines or cable having the scalpel bond part.

[Claim 13] It is optical wiring equipment characterized by to prepare the lens in the plate aperture which it is an electric lines or cable, the light-corpuscle child who performs photo electric translation, and optical wiring equipment which has an optical-transmission means, this light-corpuscle child and this optical-transmission means are fixed so that optical coupling may be mutually carried out within this optical wiring equipment, this light-corpuscle child is constituted including a field type light-corpuscle child, and is arranged between these optical-transmission meanses with this light-corpuscle child.

[Claim 14] It is optical wiring equipment which is an electric lines or cable, a photoelectrical transducer, and optical wiring equipment that has an optical-transmission means, this photoelectrical transducer and this optical-transmission means are fixed so that optical coupling may be mutually carried out within this optical wiring equipment, and is characterized by for this electric lines or cable and this photoelectrical transducer located between these optical-transmission meanses to divide the field which has two or more field type light emitting devices, and the field which has two or more field type photo detectors, and to be constituted it.

[Claim 15] It is optical wiring equipment which it is an electric lines or cable, a photoelectrical transducer, and optical wiring equipment that has an optical-transmission means, this light-corpuscle child and this optical-transmission means are fixed so that optical coupling may be mutually carried out within this optical wiring equipment, and is characterized by constituting this photoelectrical transducer including the two-dimensional-array-ized two or more field type light-corpuscle child.

[Claim 16] It is optical wiring equipment which it is an electric lines or cable, a photoelectrical transducer, and optical wiring equipment that has an optical-transmission means, this light-corpuscle child and this optical-transmission means are fixed so that optical coupling may be mutually carried out within this optical wiring equipment, and is characterized by removing this substrate after this photoelectrical transducer forms a barrier layer on a substrate.

[Claim 17] It is optical wiring equipment which is an electric lines or cable, a photoelectrical transducer, and optical wiring equipment that has an optical-transmission means, and is characterized by preparing the through hole electrode in the field in which this light-corpuscle child and this optical-transmission means are fixed to so that optical coupling may be mutually carried out within this optical wiring equipment, and the light emitting device is not formed in this photoelectrical transducer.

[Claim 18] Electronic equipment which has the 1st board and the 2nd board which are characterized by providing the following To connection between this 1st board and the 2nd board, it is an electric lines or cable. Photoelectrical transducer Optical-transmission means

[Claim 19] It is optical wiring equipment characterized by being an electric lines or cable, the light-corpuscle child who performs photo electric translation, and optical wiring equipment which has an optical-transmission means, fixing this light-corpuscle child and this optical-transmission means so that optical coupling may be mutually carried out within this optical wiring equipment, and constituting this light-corpuscle child including a field type light-corpuscle child, and this optical-transmission means consisting of single mode fibers.

[Claim 20] It is optical wiring equipment which it is an electric lines or cable, the light-corpuscle child who performs photo electric translation, and optical wiring equipment which has an optical-transmission means, this light-corpuscle child and this optical-transmission means are fixed so that optical coupling may be mutually carried out within this optical wiring equipment, this light-corpuscle child is constituted including a field type light-corpuscle child, and is characterized by to fix this light-corpuscle child and this optical-transmission means using Si substrate in_which the V groove was formed.

[Claim 21] It is optical wiring equipment which it is an electric lines or cable, the light-corpuscle child who performs photo electric translation, and optical wiring equipment which has an optical-transmission means, this light-corpuscle child and this optical-transmission means are fixed so that optical coupling may be mutually carried out within this optical wiring equipment, the aforementioned light-corpuscle child is constituted including a field type light-corpuscle child, and is characterized by using this optical-transmission means for connection between a liquid crystal display and a computer.

[Claim 22] It is optical wiring equipment characterized by being an electric lines or cable, a photoelectrical transducer, and optical wiring equipment that has an optical-transmission means, fixing this light-corpuscle child and this optical-transmission means so that optical coupling may be mutually carried out within this optical wiring equipment, and constituting this photoelectrical transducer including a field type light-corpuscle child, and this optical-transmission means having the sheet configuration where the core was located in a line in the shape of an array.

[Claim 23] The distribution cable for the signal connection between electronic equipment or in electronic equipment characterized by providing the following The electrical connector section in which desorption is possible between the exteriors An optical-transmission means by which a lightwave signal can be transmitted It is the light emitting device which is equipped with the light-corpuscle child for carrying out photo electric translation, and is modulated by the

electrical signal connected by the current carrying part of the electrical connector section in which this desorption of this light-corpuscle child is possible. It is the electronic-circuitry element which hybridized the aforementioned light-corpuscle child's bare chip on this Si substrate by direct flip chip mounting so that IC and electric contact which it consisted at least of one side of the photo detector which changes the lightwave signal transmitted with this optical-transmission means into the electrical signal for connecting with the current carrying part of this electrical connector section, and integrated, alignment of this light-corpuscle child was carried out, and he was fixed so that optical coupling might be carried out to this optical-transmission means, and were integrated on same Si substrate might be obtained.

[Translation done.]